Knowledge & Scientific News

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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.Soc., and E. S. GREW, M.A.

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The Californian Sea-Elephant.

By R. LYDEKKER.

THE Natural History branch of the British Museum has recently received, as a gift from the Hon. Walter Rothschild, a male and female of the Californian sea-elephant, or elephant-seal, a species practically on the verge of extermination, and hitherto unrepresented in the collection, except by an old and badly-stuffed example of the female. Sea-elephants, of which two species are now generally recognised by naturalists, are the largest of all seals, exceeding in this respect even the walrus, which is the biggest member of the group inhabiting the northern hemisphere. The largest and hitherto best-known species is the one inhabiting the Falkland, Kerguelen, Macquarie, and numerous other islands in the southern ocean, of which a male example (likewise presented by Mr. Rothschild) has for some years been exhibited in the museum. In that species the bulls, as the males are called by sealers, may measure as much as twenty feet in length, although the cows are not much more than half that size. The new male of the Californian species, which appears to be a full-grown animal, does not, however (as mounted by Mr. Rowland Ward), measure more than fifteen feet nine inches from the muzzle to the tip of the short tail; the corresponding measurement of the female being eleven feet two inches.

From other seals the adult male of the sea-elephant is distinguished by having a short proboscis or trunk, which, although ordinarily limp and flaccid, is capable of inflation under the influence of excitement, and is in the latter condition in the mounted specimen, as shown in the figure. As the muzzle of the cow is of the normal type, it is evident that the trunk of the bull is a secondary sexual character. The Californian species appears to be mainly distinguished by the greater relative length and slenderness of this appendage.

The species, which received its scientific name in 1866, formerly occurred in considerable numbers along the coast of Lower California from Cape Lazaro to Point Reyes; but was stated by an American naturalist in 1890 to be then practically extinct. It appears, however, that a small herd was still surviving on the island of Guadalupe, between one and two hundred miles off the Californian coast, and it was from this herd that the specimens in the museum were obtained. Photographs of the herd presented by Mr. Rothschild to the museum show that the seals frequented a beach strewn with huge boulders of rocks of apparently volcanic origin, between which are stretches of fine shingle.

The southern species (which formed the subject of an article in this journal some years ago) has been known to science from the time of Linnæus; and, like its northern cousin, has been the object of unremitting persecution for the sake of its oil for at least a century and a quarter. So severely, indeed, have both species been persecuted that the wonder is not that they are now more or less nearly (or even completely) exterminated from many of their old haunts, but rather that there are still any survivors. The naturalist, Weddell, for instance, stated so long ago as the year 1823 that sea-elephants were even then nearly extinct in South Georgia, whence no less than twenty thousand tons of their oil had been shipped to London, to say nothing of huge quantities carried to other ports. At a still earlier date, 1802, six hundred of these huge creatures are reported to have been killed on King Island, in Bass Strait, in the course of a period of ten weeks between the beginning of March and the end of May.

Important information with regard to the present *status* of the sea-elephant in the southern ocean was acquired during the late Antarctic expeditions; a summary of which, by Dr. E. A. Wilson, will be found in the second volume on the natural history results of the National Antarctic Expedition published last year by the British Museum.

From this it appears that in the Macquarie Islands (to the southward of New Zealand) all the old males have been killed off, as none of the individuals seen were more than eight feet long, and all lacked the proboscis of the full-grown bull. A considerable number of young animals were, however, seen; but even this did not represent anything like the total, as the creatures, despite their bulk, are so completely concealed by the clumps of tall grass amid which they lie that they require to be walked up before their presence can be detected. A few years before the visit of the expedition twenty tons of sea-elephant oil were obtained by a party of five sailors. This immaturity of the sea-elephants on the Macquaries opens up the question as to how long these seals take to arrive at their full size—a question to which it is very doubtful whether it will ever be possible to give a satisfactory answer.

One interesting piece of information acquired during the recent expeditions is to the effect that these seals occasionally wander much further south than had been previously supposed. One half-grown male was, for instance, obtained by the *Discovery* party on South Victorialand, at least one thousand miles away from the nearest island on which the species is known to breed; and a second specimen was reported from the South Orkneys by the Scottish expedition. These discoveries seem to effectually disprove the idea that sea-elephants never wander far from land.

In the New Zealand seas the Macquarie Islands are generally stated to form the northern limit of the species, which is unknown on the Auckland and

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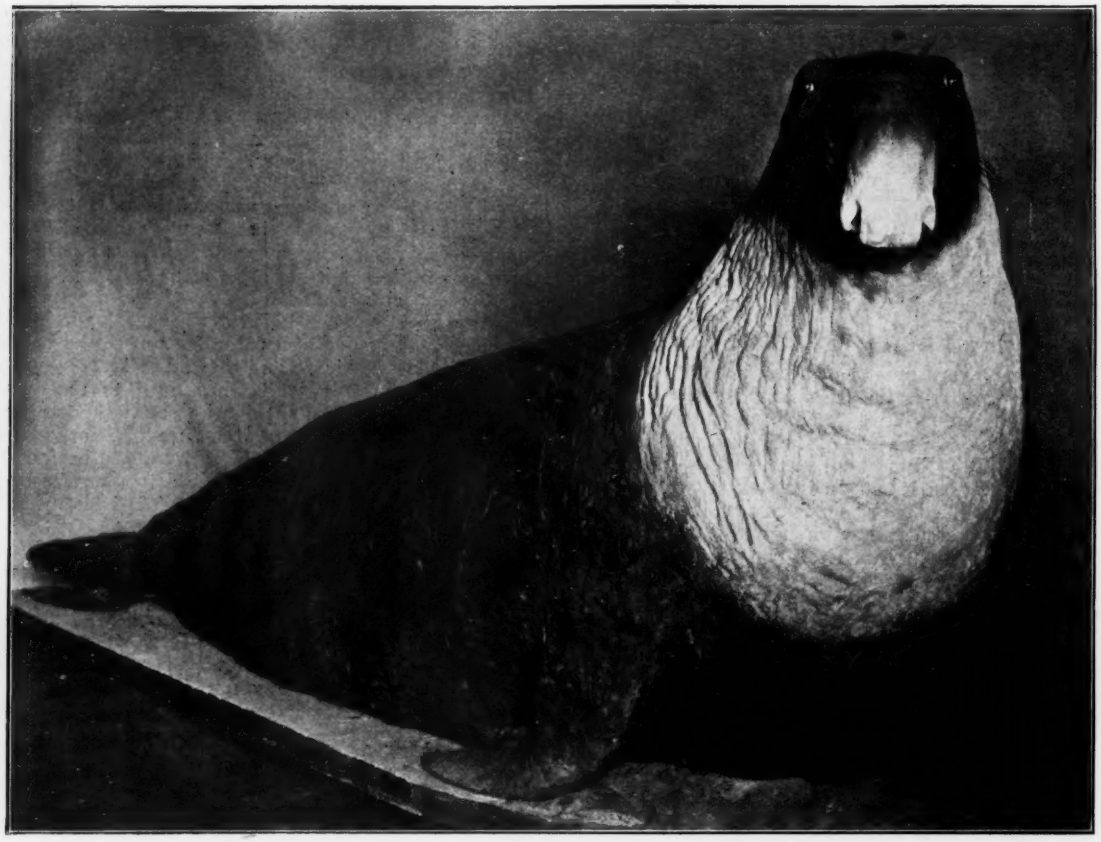
Chatham Islands. This is confirmed by the report of the expedition recently sent by the Southern Dominion to the islands in question, in which no mention is made of the occurrence of sea-elephants. Kerguelen, Marion, Heard, and Crozet Islands form other resorts where the species was formerly abundant; while, in other directions, these seals also inhabited Tristan-da-Cunha, Juan Fernandez, the Falklands, New Georgia, and Inaccessible Islands, and, it is reported, the Cape of Good Hope, although this may be doubtful.

With this essentially southern distribution it is most remarkable that a closely allied species should be found on the coast of California, north of the tropic of Cancer. How it got there, and whence it came, are mysteries still unsolved.

Although sea-elephants belong to the same family as the ordinary seal (with which they agree in the absence of external ears and the normally backward direction of the hind-flippers), they present certain curious resemblances to the sea-lions and sea-bears, collectively known as the eared seals. The bulls, for instance, as already mentioned, are nearly double the size of the cows, just as in sea-lions and sea-bears. The former also remain a long time on land in the breeding season, during which they become much emaciated by their prolonged fast; this being also a feature in which they resemble the two latter. Whether the old bull sea-elephants assemble "harems" of cows over which they watch with jealous care, after the fashion of the eared seals, is, however, according to Dr. Wilson, still unknown. Judging from the account given in Anson's Voyages, I should be inclined to say that they do not. Be this as it may, sea-elephants, like sea-lions, come on shore for the purpose of changing their winter coats, as well as for breeding.

From this similarity in habit to sea-bears and sea-lions, coupled with the disparity in the sizes of the two sexes, Dr. Wilson comes to the conclusion that the sea-elephant, in place of being (as hitherto considered) the most specialised of the true seals, is really the most generalised, and the only one which retains in these respects evidence of near affinity with the eared seals. If this be correct, the idea that the true seals and the eared seals were separately derived from distinct groups of land animals is, so to speak, knocked on the head.

The two specimens are at present exhibited in the entrance hall of the museum. The male is mounted with the head and neck elevated, while the small female is lying on her flank by his side.



Copyright. [*Rowland Ward.*

The Californian Sea-Elephant.

A Southern Hemisphere Observatory.

FROM a New Zealand correspondent we have received an interesting description of the Observatory and the 9-inch refracting telescope at St. Mary's Seminary, Meanee, Napier, New Zealand. These particulars are accompanied by several star photographs, one of which is specially interesting as affording a view of the comet Daniel as seen by southern observers.

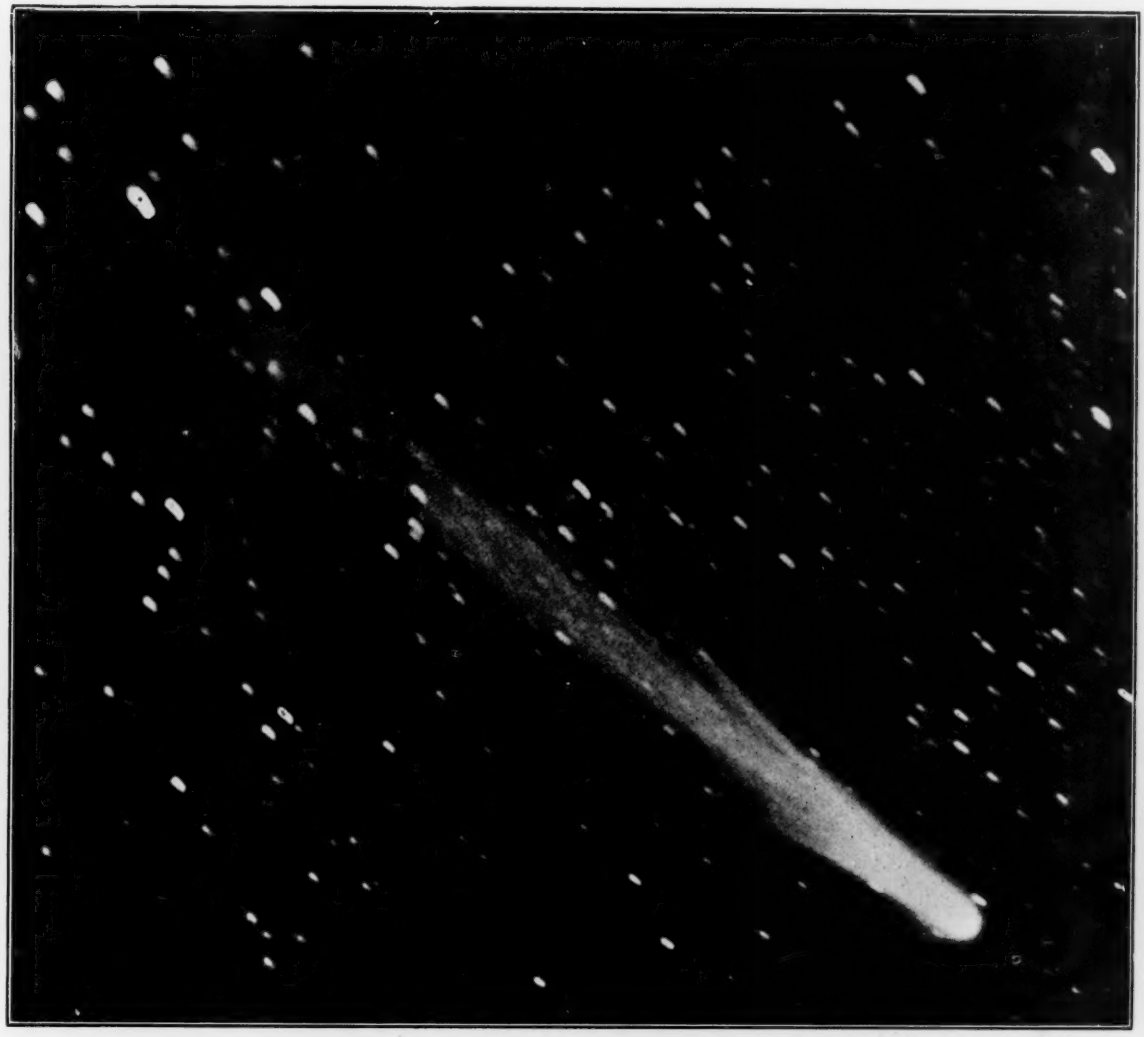


Fig. 1.—Comet Daniel, taken August 18, 1907, with 3½ Dallmeyer portrait lens, exposure ¾ hour, at Meanee Observatory, New Zealand. Star with back spot near end of tail is γ Geminorum.

The Napier Observatory is a small wooden building twenty feet square with an iron dome-shaped roof, and its telescope is supported on a concrete pier. The telescope is equatorially mounted on a massive iron pillar in two parts, with adjustment in azimuth at the junction, and considerable adjustment in latitude at the top. The hour circle is 12½ inches in diameter, and divided on silver reading by verniers to 10 seconds. There are two declination circles, one 2 feet in diameter, the other 1 foot in diameter, both divided on silver, and reading by verniers to 10 seconds. The hour and declination circles are provided with electric illumination. The clamp and slow motion in right ascension are worked by means of rods from the eye-end. There is a flap shutter attached to the dew-shade of the main tube, and two counterpoises sliding on brass rods to counterbalance accessories. A position circle 7 inches diameter, divided on silver and reading by verniers, is fitted at the eye-end. There is a complete battery of eye-pieces, including sun and star diagonals, transit and comet eye-pieces, Dawes' solar eye-piece, and astro eye-pieces ranging from 60 to 100 diameters. The eye-end, with rack and draw-tubes for visual purposes, can be replaced by a photographic camera attached by bayonet joint. This can be used to photograph the stars in the principal focus, or to photograph the sun or moon with the aid of an enlarging lens.

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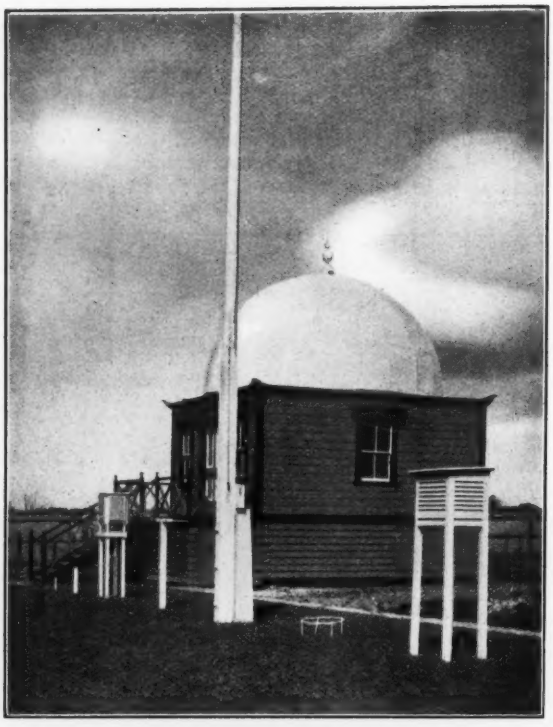


Fig. 2.—View of the Observatory.

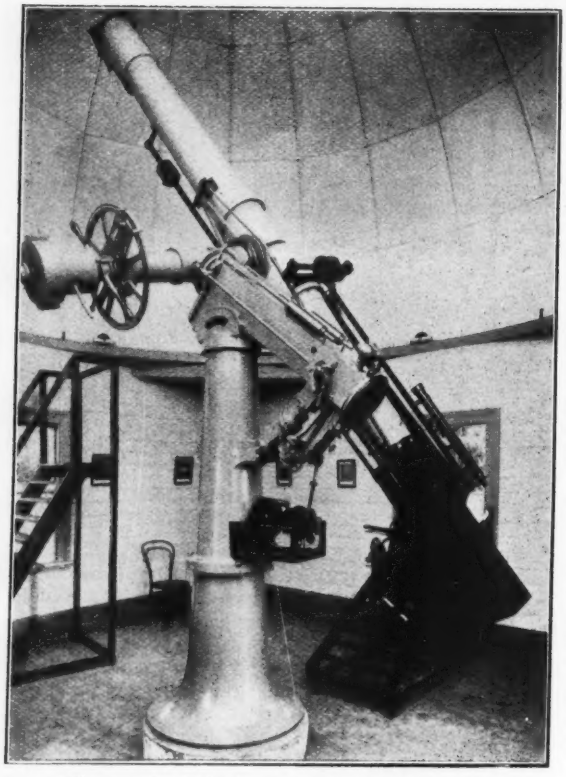


Fig. 3.—9 In. Refractor used as Spectrohellograph.
(By Cooke & Sons.)

Attached to the main tube is a large finder with a 2½-inch object glass, and also a guiding telescope with a 5-inch object glass, cross slide to eye-piece, dark field electric illumination, and iris diaphragm to regulate the amount of light. This is used as a following telescope when photographing the stars. The object glass is 9 inches full clear aperture and 12 feet 8 inches focal length. It is of the photo-visual type. The observatory, which has been fitted by Messrs. Cooke and Sons, of York, is very fully equipped for photographic and spectroscopic work, and there are excellent reasons for expecting a large amount of good and useful work from this unpretentious observatory.

A "White" Rainbow.

COLONEL W. F. BADGELEY writes to us from Devizes as follows:—Some of your readers no doubt observed the "white" rainbow that was to be seen at places in the four shires of Worcester, Stafford, Gloucester, and Wilts., on the forenoon of February 2. Being Sunday, it is possible not many saw it, for at the time—10 to 11 o'clock—the population were doubtless indoors.

It was an arc of white, like thin, shining cloud, and the rainbow colours were faint and not noticed by some observers. It was broader than an ordinary rainbow, and the ends of the arc faded away some distance above the ground.

Here, in Devizes, we have had no rain for ten days, and, this county being on the green sand, it needs but a dry day or two to drain off superfluous water. The roads are, however, as muddy and the fields as soppy as if it had rained every night, and the moisture drips from the windows in the mornings and the dew-ponds are very full. All which tends to show that there has been much vapour in the air, and we have had cloudy and foggy weather most of the time, excepting on that Sunday, when the weather was fine and clear.

I conclude, then, that the bow was made in the vapour which the sun would have lifted to the upper air between the cloud region and the earth just about that time of day. The sun had a great depth of material from which to produce the bow, much more than a shower of rain would give, and so made what was equivalent to many rainbows behind each other. This accounts for the greater breadth of the band, and also for the whiteness, for the commingling refracted beams would reproduce most of the light as white. The paleness of the colours is thus accounted for in the body of the bow, and in the edges was due to the minuteness of the vapour globules. That it did not reach the ground with its ends is because the sun had not left much vapour near the ground.

It is extraordinary that identical weather should have occurred over such a large area.

Aeronautical Supplement.

THE increasing size and importance of the Aëronautical Supplement which has for some months past been enclosed in the ordinary number of "KNOWLEDGE" has called for a new arrangement in its disposition and distribution. It will be sent separately to those subscribers who intimate a wish to receive it; and it will also be issued by the editors of "KNOWLEDGE" as a distinct publication.

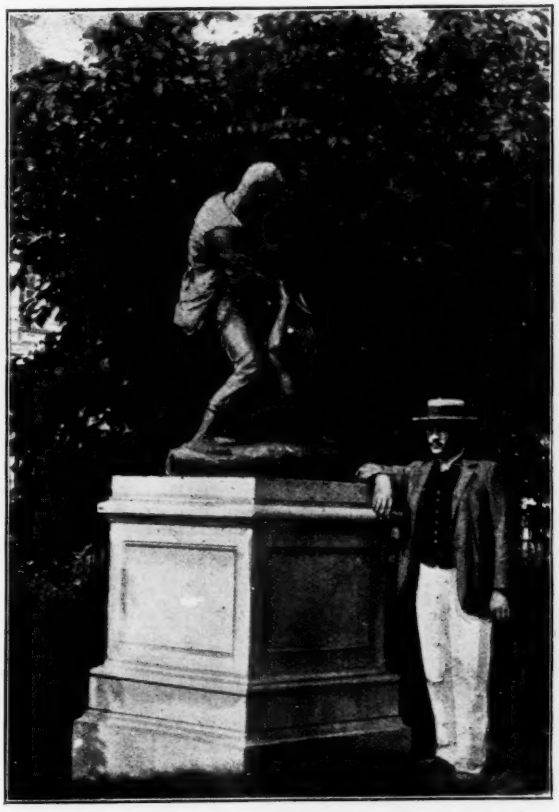
A Patient of Pasteur.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

SOME seventy years ago a mad wolf rushed through a district in the Jura Mountains biting every living being it chanced to meet, and Pasteur, who was then a boy, was so haunted by the horrible scenes he witnessed that he never lost sight of the great need there was of a cure for rabies.

His first systematic experiments began in 1880, and five years later he was able to announce the discovery of the method of treatment that now bears his name. His first patient was a boy of nine, who was cured after having been bitten in 14 places by a mad dog.

Shortly afterwards, towards the end of 1885, M. J. Jupille, the original of the accompanying photograph,



underwent the treatment. He was then a lad of fourteen, living in a small village in the Jura. While tending his sheep in company with five other boys, a mad dog burst into the group. All took to their heels with the exception of Jupille, who covered their retreat, and wrestled with the dog. Having overpowered it, he tied its jaws together and drowned it in a neighbouring stream.

As he had been severely bitten on the hand, he was sent to Pasteur, and although he did not reach Paris until six days after the bite, the treatment proved permanently successful.

A prize for his bravery was awarded him by the French Academy, and he was subsequently appointed concierge of the Pasteur Institute, in front of which was erected a statue of him struggling with the dog.

Beaded or Pearl Lightning Flashes.

By WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.

IN the June and July numbers of this Journal of last year, I attempted to show that the evidence of the occurrence of flashes of lightning of the "beaded" form indicated that we were not here in the presence of a distinct form of lightning discharge at all, but of an "after effect," due to the incandescence of the air particles. Since the above dates three accounts of the observation of "beaded" flashes have been published, and they are of such an interesting nature that they may be referred to at some length here.

The first was printed in the May number of the *United States Monthly Weather Review*, for last year (Vol. 35, No. 6, p. 228). The account was communicated by Professor Bigelow, and was preceded by some remarks by the Editor of that journal.

ELECTRIC STORM IN SOUTHERN CALIFORNIA.

["The following account of an interesting electrical phenomenon at Calexico, San Diego County, Cal., on the evening of May 27, 1907, is communicated by Professor Bigelow, from a letter addressed to him by C. E. Grunsky, the well-known civil engineer, in charge of the reclamation of the Salton Lea. Mr. Grunsky has paid special attention to the rainfall of California, and the snow on the mountain tops, and is probably correct in saying that the following is a comparatively rare phenomenon. Calexico, as its name implies, is on the boundary between California and Mexico, in longitude 115° 30′ west.—EDITOR."]

"In this country, where it never rains, I was fortunate enough yesterday evening to witness a fine and certainly very unique electrical display. Between 5 and 6 p.m., a pronounced storm of small extent, topped by a fine cumulus cloud, was seen in the north-east, but in this valley another, with greater spread of clouds, was seen in the west, but it did not look as it would bring rain. Somewhat of a sand-storm preceded the storm from the north-east, which seemed to be scattered by the time it reached the international boundary. Toward 8 p.m., the storm from the west broke loose with quite fierce lightning for a time and rain, with a continuation of lightning. With the engineers of the Californian Development Company, I was out watching it. Mr. Herrmann and Mr. Clarke, of the engineering force, were the first to observe an unusual phenomenon entirely new to all of us. There were four or five electrical discharges from clouds to earth, some striking within 1,000 to 2,000 feet, which left their courses distinctly marked by beautiful strings of fire-beads. There seemed to be a bead of fire at every angle in the course of the spark, and these beads remained visible long enough to be clearly seen, perhaps one-quarter second or longer. I personally saw the phenomenon three times, twice very clearly, once through the foliage of trees. Mr. H. T. Cory, the chief engineer and manager of the Company, was the last to see it—only one flash.

"I should add that there were many discharges from clouds to earth that were not of the beaded variety."

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The second description, printed in the same journal (Vol. 35, No. 8, August, 1907), is communicated by Dr. Irving Langmuir, and is dated September 11, 1907, Stevens Institute, Hoboken, N.J.

It reads as follows:—

"I have read with interest an account of a peculiar phenomenon in connection with a flash of lightning, on page 228 of the May, 1907, number of the *Monthly Weather Review*.

"I have also seen such phenomena and would like to bear testimony to their occurrence on not very rare occasions, at least, in the mountains of Switzerland. I remember three storms I have witnessed at different times in which flashes of lightning left their paths distinctly marked by strings of fire-beads. Two of these storms were in the Alps, one at Berchetesgaden, in Southern Germany, and one on the mountain near Lake Lucerne, in Switzerland. The third at Jackson, N.H., in the White Mountains. Each of these three storms was exceptionally violent, among the most violent I have ever witnessed. The phenomenon was observed only with flashes which were comparatively close, within perhaps 2,000 feet. In each storm several flashes left beaded trails, but not every flash which struck near by exhibited that peculiar appearance.

"I should estimate the time during which the beads remained visible as at least one second, a time amply sufficient to observe distinctly. It appeared to me that the whole course of the flash remained luminous, with a dull red glow, but that at intervals along the path bright points like sparks appeared to remain suspended in the air.

"The sparks appeared to be moving horizontally as though blown along by the wind.

"I have spoken many times with others about the phenomenon, but have met no one, even among experienced mountaineers, who had observed anything like it. I had, therefore, begun to suspect that the phenomenon was of a subjective nature, that is, was due to some peculiar impression left upon the retina of the eye by the brilliant discharge. The appearance of the sparks drifting along with the wind is strong evidence against this theory."

From the above descriptions I think there can be little doubt that what was observed was the "after-glow" caused by the highly-heated air particles, which, as I previously pointed out, are not instantaneously extinguished, but remain luminous for an appreciable interval of time.

It is most interesting to note that, in the second account, the after-glow was so prolonged that Dr. Langmuir was able to detect a movement due to the wind, just as in some cases the luminous trail of a meteor has been noticed to drift and change its form, owing to air-currents. This observation is of particular value because it bears directly on the origin of "ribbon" or "band" lightning flashes.

Attention may also be called to the remarks in the first description, that "there seemed to be a bead of fire at every angle in the course of the spark. . . ." indicating that the beads occurred at these points, as would naturally be expected. The detection of this appearance speaks well for the carefulness of the observation.

Coming now to the third and last case, this appeared in the *Comptes Rendus* of the Paris Academy (Vol. CXLV., p. 780, November, 1907), and was communicated by M. M. Luizet. The observation was made on August 15, 1907, at Sappey (altitude, 1,000 metres), near Grenoble, and was described as follows:—

"Towards 20 o'clock, when a violent storm, which raged for an hour, commenced to travel away in the E.N.E. direction, I saw a vertical flash, slightly sinuous, but very brilliant, followed after about an interval of a second by a second flash, *en chapelet*, exactly at the same place as it, and presenting the same sinuosities. Other people, like myself, saw these two successive flashes, the first brilliant and continuous, the second much less intense, red, and formed of a series of luminous dashes (traits).

"Seven seconds after the first flash, a single clap of thunder was heard. The flash was therefore produced at a distance a little more than two kilometres from the point where I was stationed, and by comparison with objects such as houses, trees, etc., seen at this distance, I estimate as 30 metres at least the length of the luminous dashes composing the second flash, and as 20 metres that of the interval separating them. Throughout the whole length of the flash, there could no have been more than a score of them."

According to this account it will be gathered that there were two distinct flashes, the first continuous, followed by one of "beaded" form a second later. I think it is quite possible that, because a "beaded," followed a "continuous" form, the observer was led to assume that they were two distinct flashes and described them as such. May it not have been that the beaded was the "residual" of the continuous discharge as in the cases of those described above? I think that this was most probable, and the references to the second flash being less intense than the first, and red, agree with Dr. Langmuir's observation, who mentions a "dull red" colour for the after-glow.

Imperial College of Science and Technology.

THE Earl of Crewe, Chairman of the Governing Body of the Imperial College of Science and Technology, presided at a meeting held last month at which the following members were present:—Mr. Gerald W. Balfour, Sir Julius C. Wernher, Sir W. H. White, Mr. A. H. D. Acland, Mr. F. G. Ogilvie, C.B., Mr. J. C. G. Sykes, Dr. Glazebrook, Professor Capper, Professor Farmer, Sir H. E. Roscoe, Sir A. W. Rücker, Mr. A. Acland Allen, M.P., Sir C. Kinloch-Cooke, Mr. R. A. Robinson, Sir J. Wolfe Barry, Sir W. S. Prideaux, Sir J. Watney, Viscount Esher, Sir Arthur Bigge, Sir A. Geikie, Professor Gowland, Professor Dalby, Sir Alexander Kennedy, Mr. R. K. Gray, Professor Divers, and Mr. W. McDermott, with Mr. F. E. Douglas (acting Secretary). The Governing Body appointed as Rector of the Imperial College, Henry Taylor Bovey, Esq., F.R.S., D.C.L., LL.D., Dean of the Faculty of Applied Science and Professor of Civil Engineering at McGill University, Montreal, and Honorary Fellow of Queen's College, Cambridge.

Solar Disturbances During January, 1908.

PLOTTED from the combined observations of Messrs. J. McHarg, A. A. Buss, and F. C. Dennett. The central meridian at noon on January 1st was 0° 22′.

No. 208.—Repeated from last month's chart.

No. 1.—A spotlet, on a bed of faculæ only seen January 2.

No. 2.—Return of No. 199, the chart shows it on 5th, 175,000 miles long. Only a triangle 110,000 miles long on 9th, and on 13th only the large spot remained. In very faculic area. 2nd to 14th.

No. 3.—Two pores 4th, one 5th.

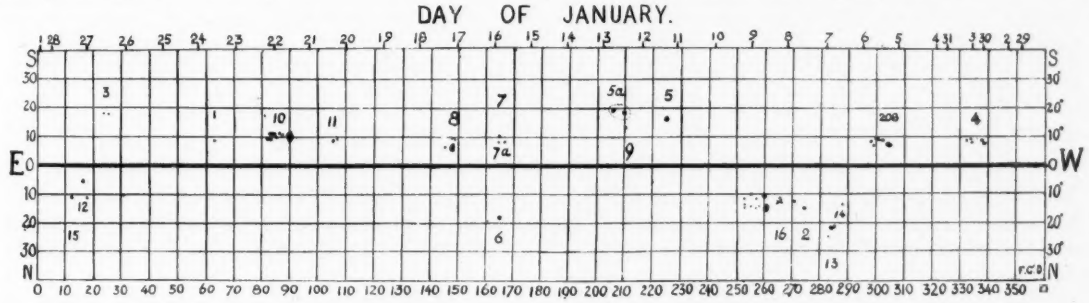
No. 4.—A disturbed tract developed pores and small spots in area of No. 197. 4th to 9th.

No. 5.—A small spot, 10,000 miles across, close to the place of No. 201. 5th to 15th.

No. 5*a*.—A pair of spotlets in a faculic area. 17th and 18th.

No. 6.—A small dwindling spot. 10th to 15th.

No. 7.—A pore, 11th to 14th.



No. 7*a*.—A pair of pores close to same area, 15,000 miles apart. 17th and 18th.

No. 8.—A spot 18,000 miles in diameter with a spotlet just east and varying pores round. Group 50,000 miles long on 17th. Almost in area of No. 202. 11th to 23rd.

No. 9.—A pore, seen only 13th, close to where 5*a* afterwards broke out.

No. 10.—A fine outbreak on the visible disc, 66,000 miles long, the largest spot 22,000 miles in diameter. 18th to 27th.

No. 11.—A pore only seen 18th.

No. 12.—A spot 10,000 miles in diameter. 21st to 24th.

No. 13.—A spot the umbra of which split, then the spot; a few pores showed. The spot 15,000 miles in diameter on February 4th. January 29th to February 6th.

No. 14.—A pore only seen 29th.

No. 15.—A pair of pores 31st, one on February 1st.

No. 16.—A pore in place marked by a cross, in middle of area formerly occupied by No. 2 with faculæ right away to the equator. January 31st to February 2nd.

The Structure of the Earth.

By J. J. STEWART, M.A., B.Sc.

A Résumé of Recent Theories.

AT a period not very remote the constitution of our earth used to be described as that of a solid crust of rocky materials, covering an interior of liquid stuff at a very high temperature. The pouring out of molten rock by volcanoes in active eruption was regarded as an almost certain proof of the truth of this hypothesis as to the condition of the greater part of the interior of man's habitation; and the comparatively rapid increase of temperature on going downwards towards the centre of the earth which was observed in deep mines made this account of the earth's structure a very plausible one. Recent researches and observations approaching the question from different quarters have led to very much changed views on the condition of our planet at a comparatively small depth below the surface.

In the year 1867 Sir William Thomson (the late Lord Kelvin) and Professor Tait stated their conclusion that the effective rigidity of the earth must be greater than that of glass, and some years later Prof. G. Darwin, reviewing the reasoning based on tidal action concluded that the effective rigidity was at least as great as steel. Other inquirers, from discussions based on astronomical data and quite independent of the preceding, judged that the rigidity resembled that of steel, and that the structure of the earth was probably that of a solid core of the same kind throughout covered by a layer of less density.

If the whole of the earth were in a liquid state no tides would be observed, for the full extent of the surface exposed to attraction would rise and fall together. If, again, the earth's mass was viscous and able to yield to a certain extent to forces tending to change its form, the tides would exist, but would be much less pronounced than if the earth's interior were rigid. Moreover, as a viscous body requires time to change its form, waves of short period would be manifest distinctly, being but little interfered with, whilst those of long period would be almost imperceptible, as the viscous earth as well as the watery envelope would slowly move under the action of the external forces. The actual tide wave is composed of a number of subsidiary tide waves of different periods, and by the principle of forced vibrations every regularly-recurring periodic change in the forces which act on the surface of the ocean is reproduced in a tide. After a thorough discussion of tidal operations made at different places and spread over a period of 33 years, Lord Kelvin and Sir George Darwin found that the waves of long period

manifested themselves with almost their full theoretical value. Hence Lord Kelvin concluded that the earth "must be more rigid than steel, but, perhaps, not quite so rigid as glass."

In 1900 and in succeeding years Mr. R. D. Oldham has described the results of his observations on the velocity of propagation of earthquake tremors, especially those recorded in the case of the great earthquake of June 12, 1897. In these records three chief phases of motion are noticed; in the first the rate of propagation has an average of 6.4 miles per second, in the second 3.8 miles per second, and in the third, the phase of long period which is accompanied by tilting of the ground, the rate of transmission is two miles per second. The first two phases are supposed to be due to wave motion transmitted through the interior of the earth, and in this nearly homogeneous material a separation of condensational and distortional waves can take place, which cannot occur in the rocks of which the earth's outer surface is composed. Thus the disturbances which arrive in succession at the place of observation travel in the least possible time along straight lines drawn through the earth's substance from the place of the shock to the point where the observing instrument is situated. They travel along chords of which lines along the earth's surface form the arcs. From a discussion of the times taken by these waves of disturbance, Mr. Oldham considers that the nucleus of the earth may have a density more nearly uniform than is generally assumed. The conditions required for the occurrence of the actual rates of propagation observed appear to be a globe with a nearly uniform nucleus not less than $\frac{1}{20}$ of the earth's radius, covered by a shell, which passes rapidly upwards into the materials which constitute the earth's outer crust. The fact that low velocities occur along chords of less than 10° points to the conclusion that this crust is not more than forty miles in thickness. The preliminary tremors of earthquakes coming from Japan to Europe reach a depth of .45 of the radius from the surface, and there attain a maximum velocity of about 9.6 miles per second for the condensational waves, the rigidity of the earth indicated by the rate of these disturbances being about $21\frac{1}{2}$ times that of granite at the depth mentioned.

Similar conclusions have been reached by Professor Milne from more recent investigations. He considers that the difference in the rate of propagation of earthquake waves through the earth's interior and through the outer crust shows that the material composing the earth is below a depth of about 30 miles, fairly homogeneous, and of a high rigidity, and that an abrupt change takes place in the nature of the substance at about the depth stated.

This estimate, that the depth of the outer crust is somewhere about 30 or 40 miles, is supported in a remarkable manner by the results of investigations which start from a completely independent standpoint. Two years ago, Lieut.-Col. S. G. Burrard, published an account of his observations on the intensity of the force of gravity in India, and came to the conclusion as the result of his geodetical surveys, that the variations of the density of the earth's crust, which are noticed are not deep-seated. This conclusion is based on the fact that the indications which are given by the time of vibration of the pendulum are supported by those given by the plumb-line. If an excess of matter is concentrated at one portion of the earth's interior, near the surface, it will exert an influence on pendulums and plumb-lines in its neighbourhood, but if the position of the portion of extra density is at a great depth, its effect, especially on plumb-lines, will be comparatively slight. Colonel Burrard found in several cases that when abnormal pendulum results occurred, plumb-lines in the same region were also affected. From this agreement he concludes that the variations in density cannot extend to a greater depth than from 30 to 40 miles, and that the variations of density, which have been actually observed are of a superficial character.

The question has been approached from an entirely different point of view by the investigators of radio-active phenomena, and the results of reasoning, based on the behaviour of large portions of the earth's mass, have been remarkably confirmed by experiments on the minute structure of its substance. The properties of radium have been found to have a bearing on the problem of the structure of the earth, which till lately was quite unsuspected. Radium has the remarkable property of maintaining itself and its surroundings at a temperature above that of neighbouring matter. The atoms of radium and of other radio-active substances contain a source of energy till lately unknown. They send out from themselves particles, moving with enormous velocities, and hence radium compounds and matter in their immediate vicinity are kept at a temperature about 2° higher than that of ordinary matter in their neighbourhood, just as a target, continually bombarded by shot moving with a high velocity, would get very hot. The Hon. R. J. Strutt has examined numerous specimens of rock from various parts of the earth's crust, and has measured the amount of radium they contain. He finds that the quantity of this element present is much more than would be required to maintain the earth's internal heat, if the earth were composed of rock throughout. He concludes from this that the internal core of the earth does not contain radium, and that it is probable that the nature of the interior is quite different in other respects also from that of the external portion forming the outer crust. The depth of the external layer is estimated as about 45 miles, and the temperature at the internal boundary of this layer is calculated from known data, and from the conductivity of the surface rocks, to be about 1,500° C. The nucleus inside this is supposed to be at this temperature throughout, just as a loaf of bread kept for a sufficiently long time in an oven at a steady temperature attains the same temperature as the oven. Thus, the temperature at the depth mentioned, whatever may be the case at greater depths would appear not to exceed the melting point of the metal platinum. The quantity of radium in a shell of rock 45 miles thick would, Mr. Strutt calculates, be amply sufficient to maintain the earth's temperature gradient as actually observed.

It is very striking that observers starting with unconnected data, and proceeding along quite different avenues of thought, should converge upon the same result, and reach the identical conclusion, that the earth consists of an outer envelope of a thickness somewhere about 40 miles, and made up probably of substances resembling the surface rocks known to us, this outer layer covering an inner and much denser nucleus composed in all probability of heavy metals. Many have suspected for a long time that the earth is an iron planet, and Sir Oliver Lodge points out that a core of metallic iron, of density 7, covered with a crust of rock 500 miles thick, of density 2.5 (the ordinary density of surface rock), together make up the known average density of the earth, which is 5.6. It seems quite

possible that the composition of our earth may be very like that of the meteorites, which sometimes reach its surface from external space. A large proportion of these consist of iron.

This new view of the condition of the earth's interior is not in accordance with the calculations of geologists, who assume "a globe still intensely hot within, radiating heat into space and consequently contracting in bulk." Changes of level are constantly going on, some areas are raised and others depressed, and these appear to require for their explanation an interior at a very high temperature, in the process of cooling down from a still hotter condition in earlier ages. It has been suggested that processes of building up within may tend to cause cooling, and produce an influence which would account for the apparent absence of radium in the interior. Steady, secular cooling of the globe has probably been going on and the effect of radium may be only to retard this to a certain extent. The life of radium is a limited one extending at most to a few thousand years. It appears to be a product of the disintegration of uranium, and the amount of this latter spread throughout the rocks must be gradually diminishing, as it passes from the form known as uranium into that of radium, and then into some inactive form of matter.

The whole problem is not yet solved, but it is one of great interest, and the coincidence of so many different lines of investigation all tending to establish the same theory of the internal constitution of the earth, as referred to above, is one of the most noteworthy features of recent scientific research.

A Burial Group of Models: The Industry of Beer-making.

Ancient Egyptian Burial.*

A VERY valuable and interesting contribution is made by Professor Garstang to the history of ancient Egyptian usages in his work on the Burial Customs of the country. In it he embodies an account of the results of excavations made during the winter seasons 1902 to 1904 in the Necropolis of Beni Hassan. Many English readers have already had the privilege of seeing some of the exceedingly beautiful and interesting models recovered from the tombs of this necropolis on the occasion of their exhibition by the Society of Antiquaries at their rooms at Burlington House. The Egyptians, as every student knows, buried with them the history of their civilisation, and it is in their tombs that it has to be sought. The care of their dead was throughout all their history the striking and central characteristic of their religion. Their ancient dwelling-places have almost entirely disappeared in successive inundations of the Nile, but for the sites of their tombs they selected the low desert bordering the valley of the Nile and beyond the reach of its waters; thus they gave to the dead a more permanent abiding place than they deemed necessary for the living. Life was ephemeral, death eternal; and on the tombs were expended the best that their art could produce in sculpture, painting, architecture, and, indeed, in all the products of a highly developed civilisation. With the dead were laid models, minute and highly finished, of all the implements of daily use. These include also groups of men and women busily engaged in brewing and baking, and giving an extraordinary impression of activity. Sometimes a well-filled granary with men at work in it was laid upon the coffin, or a boat with oarsmen in their places. Frequently a statue of the deceased was provided, so that in case the body perished, the soul might still find a habitation and not be compelled to wander forth. Arms, ornaments, children's toys, nothing was omitted for the soul's use on its long and unknown journey. The reason for this cult of the dead, which formed the central feature of Egyptian civilisation and religion, is to be sought, thinks Professor Garstang, in the material conditions of the people. Their outlook on life was bounded by the narrow strip of valley bordering a single river; beyond lay the desert shrouded in death and mystery. Each year the rising Nile waters blotted out their land and presently restored it to them fertilised for their season's crops. In a life so simple, so unvarying in its sequence from year to year, death seemed the one constant and inexplicable factor. That, too, must be a change to something better; as the Nile blotted out the land, so death blotted out life; as its waters receded leaving a reinvigorated earth, so death must be merely a passing to something better. Professor Garstang's book is profusely illustrated by excellent photographs of the tombs and their contents.

* *"The Burial Customs of Ancient Egypt," as illustrated by tombs of the Middle Kingdom, by John Garstang, B.Litt., M.A., F.S.A. London, 1907: Constable: price, 31s. 6d. net.*

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Physiological *v.* Photographic Terms.

From the earliest days of the camera it has been customary on occasions to compare it with the organ of vision and the sensitive surface with the retina. This may be useful for purposes of illustration, but, like all illustrations, it should be kept within strict limits, or, instead of helping, it will hinder a proper appreciation of facts, and the application of physiological terms to photographic phenomena is certain to lead to misunderstanding and confusion. We have been told over and over again that photographic plates are colour-blind. It would be just as true to say that a red curtain is colour-blind. Colour-blindness is a physiological and not a photographic phenomenon, and as an illustration of the selective sensitiveness of a photographic plate it is a poor illustration, except, perhaps, in a very narrow sense. I should not have taken the trouble to remark on this matter but that a still worse example of the misapplication of terms has lately become prevalent. The "Purkinje" effect is also a purely physiological phenomenon, yet the name is getting to be used to signify a certain characteristic property of gelatino-bromide plates that can just as easily be properly described. It is quite correct to say that the two phenomena are analogous from a certain point of view, but, as I just said, it is easy to find an analogy between a photographic plate and a red curtain. Even analogies may be pushed too far, but to take terms that have a specific meaning from one section of science and apply them to another on the strength of a mere superficial analogy is very blameworthy.

The Purkinje Effect.

It has been known for some two generations that if a red and a light blue are adjusted to equal brightness, the brightness will not remain equal to the eye when the intensity is changed, even though it is lowered or raised in exactly the same proportion in both cases. The red light will seem to vary more than the blue, becoming apparently unduely bright if the intensity is increased, and fading before the blue if the intensity is diminished. This is the "Purkinje" effect, and it may be expressed in many different ways. Dr. J. Precht published in November, 1899, the results of some experiments that he made to find the value of the benzoline lamp of Scheiner's sensitometer in terms of the ordinary standard amyl acetate lamp. He found it impossible to do this because the photographic effect of the two light sources varies unequally with the same proportional change in the intensity of the lights. That is, if equalised for a certain intensity or exposure time, an alteration of either intensity or exposure time, though of exactly the same proportion in both cases, will cause them to be unequal. About six months after, and without any knowledge of Dr. Precht's work, I read a paper at the Royal Photographic Society that dealt more thoroughly with this matter, and called it "The effect of wave-length on gradation." I described the results of experiments with many different kinds of plates, colour sensitised as well as ordinary, and determined the gradation given by lights of different wave-lengths. The longer the wave-length of the light within the range from the red to the ultra-violet, other things being equal, the steeper is the gradation within the ordinary range of exposure. That is, for a uniform change in the intensity of the light, red produces more effect than green, and green more than blue. There are certain exceptions that I observed and probably accounted for, but this is the rule. Sir W. Abney, independently, and I believe without knowledge that other workers were engaged on the subject, obtained very similar results which were afterwards published. This is the *so-called* "Purkinje phenomenon" of photographic plates. It accounts for the tendency to get a blueish tint by under-exposure and a reddish tint by over-exposure in photographs on "autochrome" plates, as well as for a tendency towards blueness in the shadows, and, of course, is liable to affect all three-colour work.

Agar-agar.

It must always be the practical advantages of any given medium for sensitive salts that determines whether or not it shall be employed. We have seen in recent years collodion and albumen displaced very largely—"almost entirely"—by gelatine, though the disadvantages of gelatine are not few. There is no sufficient reason to suppose that gelatine will continue to occupy the important position that it does at present, and for many years cellulose solutions and agar-agar have been regarded with a measure of hopefulness if not of expectation. There are at the present time two or three makes of printing paper with an agar-agar film. The investigation into the properties of agar-agar made by Messrs. Cooper and Nuttall, and published in the January number of the Journal of the Royal Photographic Society, is timely and important. The most striking characteristics of this substance as a medium for photographic purposes may be summed up as follows:—It contains neither nitrogen nor sulphur, and this may be theoretically regarded as a fundamental advantage, for generally the more simple a substance is the less liable is it to change. It does not dissolve in water until the temperature is raised to nearly 100° C., so that warm or even hot water may be used on agar-agar films without risk, but this means much more trouble in getting it into solution for the preparation of the film. As compared with gelatine it needs only about an eighth as much of agar-agar to give a solution of the same thickness or viscosity. Therefore a practical film of agar-agar is much thinner than one of gelatine, and it is more easily washed, especially as warm water may be used. But, on the other hand, the thinner film cannot retain so much saline matter as the thicker gelatine film. Many chemical substances that act upon gelatine have no effect or less effect upon agar-agar. For example, mercuric chloride, iron salts, formaline, &c., do not render it insoluble. Many other details will be found in the communication referred to and the discussion it gave rise to.

Miscellanea.

The "White Band Chemical Co.," of South Croydon, are issuing a toning solution for developed silver prints that gives a delicate bright green image. It appears to contain vanadium, but is priced at 1s. 6d. for the two bottles. It is quite simple to use, and gives very satisfactory results.

Mr. Wm. Butler, of 20, Crosby Road, Southport, announces a new model of his well-known "Swincam" tripod stand, that is smaller, lighter, and cheaper than the previous patterns, but without sacrifice of the wonderful range and variety of adjustment that is characteristic of these stands. The new model is made entirely of metal, has telescopic legs, and a head 1½ inch in diameter.

CORRESPONDENCE.

Musical Sands.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In the last issue of "KNOWLEDGE" there appeared a note on the above. The writer thereof does not appear to be aware of the fact that when exhibiting his sample of Maine Sand at the Physical Society, Mr. Skinner referred to my previous investigations and experiments, and stated that he had verified my results. Nor did he give me the credit, which, amongst other things, is, I think, due to me, of being the first to discover that notes from sands could be created and intensified by means of glazed vessels and plungers. These, and other facts, were published in *Nature* in 1891, and I showed then that I had been able to produce a musical sand artificially by following out the conditions upon which I based the theory which I published in 1888. This sand was exhibited at the Royal Society's *soirée* in 1892. Sir William Crookes took a considerable interest in the subject, and verified the facts which I had published (see *Chemical News*, July 10, 1891), after a demonstration which I gave before several physicists at his house.

The late Professor Tyndall also followed my researches, and agreed with my conclusions *in toto*. After conducting some experiments with sands which I sent him, he wrote that the explanation was pretty obvious; it was "plainly due to the friction of the sand granules when pressed together and compelled to move over each other," and that he was glad to find his explanation did not differ from mine. He also thought that the echoes from the surfaces of the more distant granules must have some effect. I had not considered this.

Regarding the slipping of a cup over a saucer, may I give a simple explanation of this? When any hot liquid is poured into a cold cup the air confined within the space enclosed by the circular rim at the base of the cup expands. This cushion of air, therefore, is forced out of the cavity at all points of contact between the cup and the saucer, and a current of cold air flows in to take its place. Consequently, the friction between the cup and the saucer is considerably reduced by the presence of these currents, and the cup slips over the saucer more easily. There is no evidence, microscopic or otherwise, of any fine fragments of glaze which could possibly act as "roller bearings." Indeed, if there were such dust existing, it would be in the form of minute *flakes*, and would prevent skidding! By actual experiment I have found that (*a*) the cup slips more easily over the saucer when its interior is heated; (*b*) conversely, as the interior cools the tendency to slip is reduced; (*c*) the smaller the air cavity at the base the less easily does the cup slip, so that a flat-bottomed cup does not slip at all when heated; (*d*) a small quantity of liquid poured into the saucer closes up the channels for the ingress and egress of air between the cup and the saucer, thus stopping the circulation of the currents before referred to; (*e*) two small holes drilled (opposite to each other), one in the upper part of the circular base rim and the other in the lower, will allow the air to circulate, and so prevent slipping.

Yours, etc.,

Strawberry Hill. CECIL CARUS-WILSON.

[The explanation that the slipping of a cup on the saucer was due to the presence of microscopic particles, on which the cup glided as on small spheres (acting like roller-bearings), was suggested to the writer of the note by a physicist who is a Fellow of the Royal Society, and an ex-Professor of Physics at the Royal College of Science. We are not, therefore, disposed to disregard it in favour of Mr. Carus-Wilson's explanation.

—Eds. of KNOWLEDGE.]

Is there a Central Sun? Are the Pleiades a Physical Group?

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—The object of my article, published in your issue of last December, which has led to this controversy, was to show that all the evidence is against the hypothesis of the sun describing a closed path round a centre. I am pleased to see that, on this main point, Mr. Henkel agrees virtually with me, since he says: "I think it is unlikely that the sun's path is a *closed one*," though he bases his belief on deductions from observations, while I base mine on the result of calculations. But I would object to the methods of Mr. Henkel in suggesting that such calculations are inaccurate.

In order to prove the alleged absurdity of a formula, which can only be applied to closed paths (and which I only applied to the closed orbit of the sun *should* there be one, and precisely in order to prove that there could be none), he applies it to a parabolic path. Everyone knows that the Harmonical Law does not refer to parabolic or hyperbolic paths, but to the elliptic ones. It applies evidently also to the circular orbits, but not to them alone as Mr. Henkel pretends when he asserts that we cannot employ Kepler's third law, except for *circular orbits*. Now, Kepler himself applied it to the planets, none of which describes a circular path. Professor Young, in his "Text-Book of Astronomy" (page 277), applies it to the determination of the mean distance of an asteroid whose period is known, and in the same page he gives its demonstration for circular paths.

The demonstration of this law for *elliptical* orbits is more complicated, as it involves the law of areas, but it is given in most of the works on Celestial Mechanics. Mr. Henkel may find it in Loomis's "Treatise on Astronomy," page 134. Moreover, an author who is a favourite of Mr. Henkel as well as of mine, the late Richard Proctor, wrote in his masterpiece, "Old and New Astronomy" (1892, page 207):—

"Kepler's third law is extremely important. It may be regarded as the fundamental law of the celestial motions. It presents the influence of gravity as a bond associating the motions of all the orbs of the Universe, whether of double suns round each other, or of primary planets round suns, or of secondary planets round their primaries."

The above quotation shows conclusively that to apply the Harmonical Law to a hypothetical closed path of the sun, should there be one, is not "to assume that the sun's orbit is a circle" as, in the words of Mr. Henkel, "Professor Marmol virtually does." I should be very sorry if I had ever assumed such a thing.

Now about the Pleiades. I should like to be allowed by Mr. Henkel to use the data at our disposal, however strictly exact or simply approximate, as freely as he does himself. When I use them, he contends that we know nothing, "neither the mass, nor the distance of Alcyone, nor the forms of the orbits the others members of its system may describe about it." But in his very able article published in your issue of last July, he said: "If, with the late Miss Agnes Clerke, we take the probable parallax of Alcyone to be 0".017, in that case this star must be 170 times as bright as our sun, Electra and Maia being 83 and 70 times respectively as bright as our sun," etc.

I wish to quote, also, Miss Agnes Clerke, besides other distinguished astronomers, to show that, since Dr. Mädler, of Dorpat, suggested, more than half a century ago, that the Pleiades, with their chief star Alcyone, were the centre of the starry universe, many results of the observation as well as of the calculation have been continually weakening not only Mädler's hypothesis, but also the theory of the unity of the Pleiadic system.

In her "Problems on Astrophysics," Miss Agnes Clerke says: "The assembled stars have a common drift, which is most likely a perspective effect of the sun's advance in the opposite direction. If this be so, their light spends just 200 years in reaching the earth, the rate of our progress towards the constellation of Lyra being taken at 12 miles a second." And, further on: "A beginning has been made in the discrimination of the genuine Pleiades from their optical companions. The definite character of their proper motion has made actually feasible what, in other similar collections, is only remotely possible."

Miss Clerke, then, shows how the heliometric measures of Professor Elkin led, as far back as 1885, to the *dismissal* of eight stars of the group which proved their independence by dropping out of the ranks. She adds that in a few years the comparison of the photographs then taken with those taken thirty years before may be expected to bring into view relative displacements, consequent upon "*the*

abandonment of a multitude of pseudo-Pleiads." (The italics are mine.)

"It appears," Professor Pickering wrote, "that the total number of stars in the region of Pleiades is actually less than in adjacent portions of the sky in equal area."

According to an article published in *Astronomische Nachrichten*, by Mr. Stratonoff, this astronomer, too, was led by a study of stellar distribution in the neighbourhood of the Pleiades to suggest that the physical associates of Alcyone are comparatively few.

Many other quotations could be here produced which would tend to show that the Pleiades, taken as a whole, do not constitute a physical group, though a portion of that interesting constellation may—and on this point I gladly agree with Mr. Henkel—form a complicated system whose centre would probably be Alcyone, which should be then *a* central sun, like Sirius is *a* central sun of a system much less complicated—the Sirian system.

Yours, etc.,

London, N.E. F. T. del MARMOL.

[I venture to make a few final remarks on Professor Marmol's letter. Kepler's three laws, discovered by observation, were shown by Newton (Principia Props., I., XVII., etc., of Book I.) to follow from the law of gravitation combined with the laws of motion. The third law (Harmonic Law), usually enunciated as "the squares of the periodic times (of any two planets) are as the cubes of their *mean distances*" (from the sun), is evidently without meaning for bodies moving in open orbits, such as parabolic or hyperbolic comets. The form used by Professor Marmol $\frac{V^2 d}{M}$ = constant, may be derived from this. The "law of areas" is a necessary consequence of the planet being subject to an acceleration resident at the sun, and would be true *whatever the variation of this acceleration* (Principia I., Prop. I.). The form of the planetary orbits, *and* the Harmonic Law show that this acceleration varies inversely as the square of the distance (*gravitation*), and the extension of this to double stars, &c., has shown that gravitation is probably universal.

Now, with regard to velocities, it is shown in most books on dynamics, and the proof is not difficult, that

$V^2 = \mu \left(\frac{2}{r} - \frac{1}{a}\right)$ μ = constant (acceleration at certain distance) sometimes written k

r = radius vector (here distance from Sun)

a = semi-major axis (mean distance)

for any conic. When the orbit is a circle, r = a, and so here

$$V^2 = \frac{\mu}{r} \text{ or } \frac{\mu}{a}$$

for an elliptic orbit V varies, being greatest when r is least *i.e., at perihelion*, and least when r is greatest, *at aphelion*. At "mean distance" r=a and so here just as in the case of a circular orbit

$$V^2 = \mu\left(\frac{2}{a} - \frac{1}{a}\right) = \frac{\mu}{a}$$

This is the only point for which Professor Marmol's formula will be true, so that it does not seem saying too much to say that he virtually assumes the solar orbit, *if a closed one*, to be a circle, but perhaps I ought to modify this and say that in applying his formula, he *either* assumes it to be a circle, *or* that the sun is at its *mean* distance. If the solar velocity be, as is conceivable, only *partly* due to attraction from *another* centre, or due to *several* centres of force, his whole argument falls to the ground. After all, I must repeat, it is only the *change of velocity*, that is, the measure of acceleration.

With regard to the Pleiades. Of course, when we *know* nothing we may *assume* many things. *Assuming* the parallax of Alcyone to be 0".017, its *brightness* will no doubt be about 170 times that of our sun, but even this does not show how many times its *mass* exceeds the mass of our sun, unless we also assume its surface conditions to be similar. Nothing prevents this from being very different. Sirius has a minute companion, discovered by the late Mr. Alvan Clark in 1862. Sirius gives about 39,000 times as much light as the companion, but its mass is probably not more than three times that of the latter (Proctor, "Old and New Astronomy," pp. 768-9). The motion of Procyon is disturbed by a body comparable with it in mass, though too faint to be yet certainly detected. The case of Algol is well known. There seems no reason whatever why there should not be dark bodies existing in space as large as, or even larger than, any of the visible stars. The enormous size and very feeble luminosity of many of the nebulæ show also that there is no relation between size and brightness. F. W. HENKEL.]

NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Dispersion of Light in Interstellar Space.

M. CHARLES NORDMANN has recently been investigating the problem of ethereal dispersion, the problem being to determine if luminous rays of different wave-lengths have rigorously equal velocities in interstellar space, and has been working for the past two years by means of a new method. Taking the case of a variable star of which the light variation is rapid and of great amplitude, such, for example, as Persei (Algol), we can by suitable means screen off all the light except that of any predetermined wave-length. It is then evident that the apparent minimum, or any other phase relative to any such monochromatic image, will not be produced at the same epoch if the velocities for different wave-lengths are not identical, and the light curves for diverse monochromatic images will be relatively displaced by an amount depending on the distance or parallax of the star.

The method of procedure consists then in observing photometrically the epochs of various phases corresponding to each of the monochromatic images of the star produced in some simple manner. An equatorial telescope is used for observing the variable star, having between its focus and the eye-piece a slide fitted with various absorbing screens. Near the focus there is also produced a small artificial star for comparison purposes, the light of both real and artificial stars thus going through the same absorbing colour-screen. Both are then viewed through an adjustable polarising apparatus of the usual type employed in photometric work. For the preliminary work, three screens have been employed, red, green, and blue respectively. It is stated that the probable error of a single measure is about 0.04 of a stellar magnitude, and that of difference of phase duration about 3 minutes.—(*Comptes Rendus*, 146, p. 266, February 10, 1908.)

Measurement of Sun-Spot Positions.

Most enthusiastic observers of solar phenomena will doubtless have been worried at one time or another over the trouble necessary to determine the positions of any special features on the solar surface at a given time. In the case of rigorous measurement the apparatus is costly and the computations and reduction tables somewhat beyond the amateur worker, and while graphical methods have been often described they have not hitherto been made sufficiently accessible for general use. It is, therefore, with great pleasure that we welcome the new series of graphic charts designed by Father Cortie, of the Stonyhurst Observatory, and issued by Messrs. C. F. Casella and Co., of Rochester Row, Victoria Street, S.W. These are similar to the "Thomson" discs, described some years ago in a French astronomical annual. They consist of a series of eight charts, printed with true orthographic projections of the parallels of latitude and meridians of longitude, corresponding to the eight values, 0° to ± 7° of the heliographic latitude of the centre of the sun's apparent disc. The original discs were drawn to a scale of 10½ inches to the solar diameter, and the published reproductions are reduced to a diameter of 6 inches, and may be had either on cardboard or on glazed linen, so that they may be used either on a sketching board at the end of the telescope, for direct pro-

jection of the sun's image, or in the case of the set on glazed linen, for placing over a disc-drawing of sun-spots and faculæ.

For projecting the solar image, a drawing board (A, Fig. 1) is supported by a light frame, which can be attached by means of a collar (B) to the draw tube (C) of the telescope (D), containing the eye-piece (E), which it should fit tightly, but so that it can just be rotated round the draw-tube. On a sheet of drawing paper or card attached to the board a circle is described of the diameter (6 inches) required to contain the projected solar image, and a horizontal diameter is drawn across the circle. Selecting the smallest spot visible on the solar surface, the whole frame is turned about the draw-tube until the spot runs along the horizontal diameter. This fixes the direction of the earth's equator

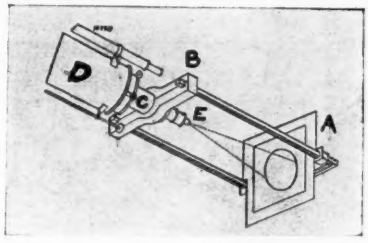


Fig. 1.

and the N. and S. points. The sun's image is now made to fill the circle by means of the slow motion gear, and the outlines of the spots and faculæ are quickly traced with a pencil, the faculæ being drawn in red for distinctness. The drawing will now be as shown in Fig. 2. Selecting the proper disc for the latitude of the sun's centre, as taken from the "Companion to the Observatory," this is placed over the drawing and adjusted so that the position angle of the sun's axis corresponds with the reading of the horizontal line on the drawing and the divided circle at the sun's limb on the disc. After minor corrections are made

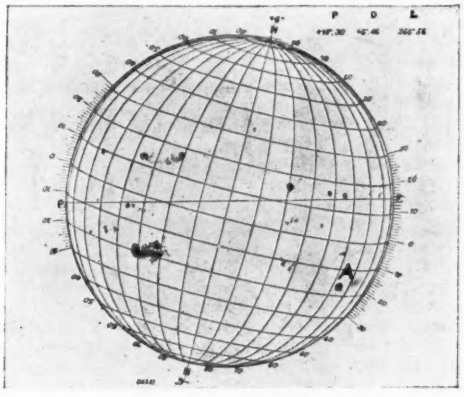


Fig. 2.

for the actual date and time of observation being different from the times given in the ephemeris, all that now remains is to read off the position of the spot on the disc divisions. Thus the position of the spot A, Fig. 2, is - 16°.8 south latitude, and - 53°.5 east of the central meridian. The true longitude of the central meridian is given in the ephemeris, and thus the above reading can be at once changed to longitude on the sun's disc.

Comparison reductions by this graphic method and the rigorous method by micrometric measurement employed at Greenwich showed that the greatest difference in longitude was 0°.6 in three cases, while in 63 cases the difference only varied between 0°.3 and 0°. In latitude, 5 cases differed by 0°.7, while 55 positions were within the limit 0°.3. For all ordinary purposes of investigation, remembering also that solar features are not fixed objects, this degree of accuracy will be all that is required.

Structure of the Solar Photosphere.

It is well known from the photographs obtained by the late M. Janssen, at Meudon, that the solar photosphere exhibits a most intricate structure, which is generally in a state of change, but of which there are certain types continually recurring. In later years Hansky has obtained large scale photographs, in which the actual life-history of a "granule" may be traced as it drifts about in the solar photospheric magma. In spite of this success, it is not yet certain how much of the detail shown on such photographs is real solar structure, and how much due to images of atmospheric disturbances produced by the violent changes of refractivity in the small masses of air and glass of the telescopic apparatus. That some such cause has an important effect is proved by the differences shown on photographs taken with a long focus lens direct at the principal focus, and on other pictures taken with an enlarging lens placed near to the principal focus. In this latter case it is quite evident that the lens faces nearest the solar image will be very strongly and unequally heated, and that whatever effect these local inequalities produce on the solar image near by will be enlarged on to the photographic plate at the same time as the solar image itself. M. S. Chevalier, working at the Zô-sé Observatory, has been investigating these phenomena with instruments of both types, and has given a most interesting review of his conclusions. Photographs taken within a minute of time usually show sufficient similarity for particular granules to be recognised, and their changes of form and position to be determined. The diameter of these granules varies from 1″ to 3″ (the scale of the original plates is 1″=0.03 mm.), so that this is very near the limit of photographic resolution with the fine grain plates employed (Lumière, Red Label), but on good plates the same granules are obtained with the enlarging lens also, and then detail about 0″.3 may be detected with certainty. The granules are usually elliptical, but the eccentricity is small, and variations from this general form may be due to pressure, etc.

The actual time that elapses between the formation of a granule and its disappearance is very short. After ten minutes, say, the whole of the details of the granular structure will be completely changed; after two minutes changes will be apparent, but will not have entirely masked the details being followed. Illustrations are given of these changes from actual photographs taken at Zô-sé, and the progress of the tiny brilliant photospheric granules can be very clearly seen even on these reproductions.

With regard to the velocities of these granules, Hansky has already stated that they move with speeds up to 40 km. per second. Chevalier practically confirms this by finding velocities ranging from 8 to 33 km. per second. The mean velocity, however, is apparently not more than 8-9 km. per second, and this renders the high values obtained for individual granules somewhat suspicious. Even the highest figures, however, are only small compared with the diameters of the granules, no one of which probably moves so much as the length of its diameter in the course of its existence. The suggestion is put forward that the apparent horizontal displacements may be due to an undulatory motion of the solar atmosphere, producing changes in form and extent of the granules as they rise or fall in the line of sight, and this view would do away with the difficulty of having to explain such high velocities for these masses of gaseous or liquid particles.—(*Astrophysical Journal*, 27, p. 12, January, 1908.)

Distortion of Photographic Films.

The question of stability of photographic films is of so great importance to all who use them for any work involving measurements of precision that any investigation

into the possible changes is of general interest. Mr. F. Schlesinger has been examining numerous plates which were taken for standard star charting purposes, and it was very necessary to find out whether the processes of development, washing, etc., left the films in the same condition as when exposed. It is very reassuring to find his conclusion is that whatever error there may be due to distortion of the film is much smaller than the bisection error of the best star images, being not more than about $\frac{1}{1000}$ mm. for the particular plates employed.

BOTANY.

By G. MASSEE.

Compositæ of Southern California.

THE family of the Compositæ includes over 10,000 species, which means that one in every ten flowering plants is a member of this family. Dr. Harvey Monroe Hall has just given a detailed account of the Compositæ of Southern California, in the publications of the University of California. In the systematic portion of the work 445 species are described as occurring within the defined area, and the standpoint assumed in regard to these species is stated by the author as follows :—

"While thoroughly in sympathy with every effort to carry systematic botany to the point where all forms are properly recognised and classified, the author is of the opinion that the exaltation of trivial forms, distinguished only by one or two variable characters, to the rank of species is conducive neither to clearness nor to scientific accuracy. A rational system of classification should bring out the natural relationship between the various forms; should, in other words, represent the cleavage of the larger groups into their component parts as it has taken place in Nature. Much of our recent work, however, has unfortunately consisted of a mere cutting across the grain, the result being a mass of chips—the so-called species—each being a purely artificial product and bearing no evident relationship to the others. This is commonly the result of hasty work where the perpetrator has been too busy to work out natural affinities, through a comparison of intergrading forms accompanied by field study."

The above should prove suggestive, even if not complimentary, to many, whose one conception of species is based on mathematical proportions.

The area worked over is mapped into life zones, which are essentially thermal belts recognised by the plant growth, and animals which they sustain. Six such zones are recognised. In addition to the above, three life areas are distinguished; these differ from thermal belts in that they indicate all the factors influencing the distribution of life, rather than only that of temperature.

Many of the characters usually considered as of specific, or even generic, value have been found to be entirely unreliable. Pappus characters are misleading and leaf characters are often elusive. Several species of *Eubœria* and *Ptilomeris* exhibit at times the pappus characteristic of *Dichæta*. Respecting *Eriophyllum ambiguum*, the author states that it would not be difficult to segregate a number of species from the aggregate *E. ambiguum* if the extreme forms could be consulted. An abundance of material shows, however, that species based on length and number of rays, union or separation of involucral tracts, character of pappus, and presence or absence of chaff on the receptacle, are neither natural nor of scientific value. Not only do these characters vary greatly, but they may be found in all possible combinations, the variations not being concommitant.

Research on the Transmission of Substances from Stock to Scion and the Opposite.

Owing to the diversity of opinion bearing on the reciprocal influence of stock on scion, and the opposite, in the case of grafted plants, Dr. Guiguard has investigated the subject in an exhaustive manner, and published his results in the *Annales des Sciences Naturelles*.

For various reasons certain plants containing hydrocyanic acid were employed; these included *Phaseolus lunatus*, L., *Photinia serrulata*, Lindl., and five species of *Cotoneaster*. This list includes both herbaceous and woody plants. The reasons for this selection for studying the migration of substances from stock to scion, or the reverse, were, in the first instance, the simple method required for the extraction of the acid, and secondly, the certainty with which very minute quantities of the acid can be recognised by the use of various reagents.

Cyanhydric acid occurs in the plants enumerated as a glucoside.

The herbaceous plants without cyanhydric acid were *Phaseolus vulgaris*, var. *compressus*, D.C., and *P. multiflorus*, L. The woody plant was *Cydonia vulgaris*, Pers. Numerous grafts were made, one series having the plant containing hydrocyanic acid as the stock, in another series it served as the scion.

The conclusion arrived at was that when a plant containing a glucoside of cyanhydric acid is grafted on to another plant not containing a trace of this substance, or the opposite, there is no transport of the glucoside from stock to scion, or from scion to stock. It is only when the two species grafted belong to the same genus, and each produces the same glucoside, as in the case of *Cotoneaster frigida* and *C. microphylla*, that the migration of this substance can be demonstrated. Hence, notwithstanding the exchange of materials effected for the purpose of nutrition between stock and scion, certain substances can remain localised in one or other of the two components of a graft, as the study of plants containing cyanhydric acid has clearly proved. In the artificial symbiosis between two distinct plants, brought about by grafting, each one retains its individuality and autonomy.

Progress in Legume Inoculation.

The special value of leguminous plants for maintaining and increasing the fertility of soils has now for some considerable time been known to be due to certain bacteria which develop nodules upon the roots of these plants, and which possess the power of rendering the free nitrogen of the atmosphere available for plant growth.

So far as leguminous plants are concerned, such as vetches, peas, beans, &c., according to the report submitted in *Farmers' Bulletin*, No. 315, of the U.S. Department of Agriculture, the artificial infection of seed or soil for the purpose of increasing the number of bacteria containing nodules on the roots of cultivated plants has passed beyond the laboratory stage, and can now be applied with advantage by the farmer and horticulturist.

The pure culture of bacteria is supplied in the form of a tablet, and is accompanied by a small bottle of culture medium. This is diluted and prepared according to accompanying directions. The seed may be treated direct or the bacteria may be placed on the land.

Inoculation is desirable when the land has not previously borne leguminous crops, or when legumes previously grown on the same land have not produced nodules. On the other hand, inoculation is useless when legumes produce average yields, and the roots show nodules in abundance, or when the soil is in such condition as to prevent the normal growth of bacteria, as when it is acid and in need of lime. Liming to correct acidity is as important for the proper activity of the bacteria as for the growth of plants. Finally inoculation will not overcome decidedly adverse conditions of weather or climate.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Variations in Water from the Channel.

A SYSTEMATIC study of the water from the English Channel has been made by M. Chevallier, samples being taken at intervals between Dieppe and Newhaven, and their composition, temperature, and specific gravity *in situ* being

determined. From the results obtained it appears that the water is colder near the coasts than in mid-channel, and that at equal distances from the coasts the sea is slightly colder on the English than on the French side. Starting from the English coast the density of the water at 0° C. shows a slight increase up to about one quarter of the distance across, and then diminishes regularly till the French coast is reached. Thus in one series of experiments the initial specific gravity of 1.02808 gradually rose to 1.02833 and then fell to 1.02770. The density of the water *in situ* also showed a diminution, though in an irregular fashion, between Newhaven and Dieppe. The difference between the extreme figures would correspond to a difference of 0.83 gram of dissolved salts per kilo. of sea-water. The proportion of halogen salts showed a similar decrease (the chlorine, for instance, falling from 19.34 grams to 19.08 grams per kilo.), whilst the amount of combined sulphuric acid fell from 2.148 grams to 2.115 grams per kilo.

Radium and Hydrophobia.

For some months past a polemical discussion has been carried on with some heat in the *Annales* of the Pasteur Institute between MM. Tizzoni and Bongiovanni on the one hand, and Dr. Calabrese on the other. The Italian doctors claimed that the virus of rabies was destroyed when exposed *in vitro* to the radiations of radium, and that animals infected with the disease could be cured by the same agent. Dr. Calabrese, on testing their statements by means of radium sealed up in a glass tube, obtained uniformly negative results, and, therefore, concluded that radium radiations had no effect upon the virus, although, as was shown by M. Rehns in 1905, the emanations of radium rendered it innocuous; but, he contended, the local injuries that would result from the application of radium emanations to the living subject would prevent its being used, even if effective, as a cure for rabies. In reply to this MM. Tizzoni and Bongiovanni admit as the result of further experiments that the presence of emanations as well as of radiations is necessary for the destruction of the virus outside the body, but point out that the fact that more than 80 animals have survived their curative treatment is sufficient proof of the possibility of using radium for this purpose. In a final reply Dr. Calabrese reiterates his disbelief in the efficacy of radium in the treatment of rabies, and the point at issue, therefore, awaits the decision of independent workers.

Spontaneous Combustion of Wool.

The frequent occurrence of fires on wool-ships during the past two years was made the subject of investigation by a Royal Commission in New Zealand, and their report has recently been published. From the results of Mr. R. J. Friswell's experiments there described it appears that the class of wool which is liable to take fire consists of trimmings and "pelt-fleshings," which contain a considerable proportion of mutton tallow. This conclusion is borne out by the investigation made by Mr. A. M. Wright to discover the cause of the spontaneous ignition of a loosely-packed heap of wool in an Australian factory. The temperature of the exterior was 87° F., while at the depth of three feet the mass was charred and smouldering, and showed a temperature of 660° F. Wool of the same class contained from 6 to 9 per cent. of moisture and from 34 to 36 per cent. of fat, which was mainly tallow derived from the flesh, and not the ordinary wool fat. This fat readily became oxidised, and being spread in a very fine layer over non-conducting material, the conditions were suitable for the rapid oxidation required to produce ignition when once chemical action had begun. Wool containing only the ordinary wool fat, without tallow, appears, in the light of Mr. Wright's experiments, to run no risk of spontaneous combustion.

The Aroma of Black Tea.

The cause of the characteristic aroma of tea has been investigated by Mr. Katayama in the laboratory of the Central Agricultural Experimental Station in Japan, and there seems to be little doubt that it must be attributed to the agency of a ferment (enzyme). The fact that the aroma is still developed in leaves after treatment with various antiseptics shows that it is not a product of micro-organisms, although, like other enzymes, the active agent is sensitive to the action of heat and of powerful chemicals. Thus tea leaves that had been exposed to the vapours of cyanogen for five hours, or had been heated for an hour at a temperature above 60° C., no longer gave off an aroma on standing. The substance to which the aroma is due may be extracted from the leaves by repeated treatment with alcohol or ether.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

The Transvaal.

THE auriferous conglomerates of the Witwatersrand, and the antimony deposits of the Murchison Range, are the subjects of a useful pamphlet by J. P. Johnson, A.I.M.M. (London, 1907: Phillips and Co.). The author remarks that the Witwatersrand is a bare ridge of hills, about 30 miles in length, running west and east through equally bare undulating veldt, and on it are situated the towns of Krugersdorp, Johannesburg, and Boksburg. Along its central portion it is paralleled to the south by a range of bush-covered kopjes, known as the Klipriviers Berg. The Witwatersrand is composed of the Lower Witwatersrand Beds, and the Klipriviersberg is made up of the Klipriviersberg Amygdaloid. Between them lie the Upper Witswatersrand Beds. The auriferous conglomerates mark the junction of the Lower and Upper Witwatersrand Beds. Their position is indicated on the ground by a line of dumps, headgears, smokestacks, and the other accompaniments of a big mining industry. In the Central Witwatersrand, the Witwatersrand Beds are seen to be resting on the Archæan Granite, and to be overlain by the Klipriviersberg Amygdaloid (Diabase). The division into a Lower and Upper Series is purely one of convenience, there being no break between the two. They may be regarded as a great quartzite group in the older division of which slates are predominant, and in the new portion of which conglomerates play the chief *rôle*. The most remarkable feature of the formation is that it is almost entirely composed of silica. The slates are nearly all quartz-slates; the quartzites are made up of quartz grains, while the pebbles are of quartz also. Gold occurs in most of the conglomerates in minute quantities.

Compression of Strata after Deposition.

Mr. H. C. Sorby, LL.D., F.R.S., the veteran geologist, now in his 83rd year, has contributed a masterly paper to the Geological Society on "The Application of Quantitative Methods to the Study of the Structure and History of Rocks." The knowledge, he says, of the final velocities of material subsiding in water is of fundamental importance, but the relation between size of particles and velocity is complex, and perhaps may be partly explained by a thin, adherent, film of water. The angle of rest obtained from sand-grains of varying size and quality enables us to ascertain approximately the velocity of current necessary to keep such sand drifting, and that needed to move it when at rest. The comparison of this angle with that observed in sedimentary rocks made of similar materials may be used to determine the amount of vertical contraction of rocks since deposition, the average in cases studied in Tertiary and Secondary rocks being from 100 to 57. In studying the drifting of sand along the bottom by currents, on which Dr. Sorby experimented in a small stream many years ago, the results are found to vary according to whether the water is depositing sand as well as drifting it, and according to whether ripples are or are not being formed on the bottom. The deposition of fine deposits, like clay, is a most complex subject, varying according to the amount of mud present in the water, and whether the grains subside separately or cohering together. When no pressure is applied, even when no further contraction takes place in standing for a year, the amount of water included in the deposited clay may be 80 per cent., and, when dry, the minute empty spaces may still amount to 32 per cent.

It is found that in some limestones the cavities have been reduced by pressure to close on the mathematical minimum,

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whereas in others, even of Silurian age, the cavities were filled with carbonate of lime, introduced from without, not long after deposition. Some oolites have had their cavities filled in a similar manner; in others most of the material of the original grain has been removed, and the present solidity is due to the filling-up of the original cavities mainly by internal segregation. Amongst fine-grained rocks the Chalk was probably originally a sort of semi-liquid with fully 70 per cent. of its volume water, and in its present state is about 45 per cent. of its original thickness; the thickness of some clays must have diminished still more; while the amount of minute cavities in rock with slaty cleavage is so small that sometimes they are nearly solid.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

Rippling of Distant Lights.

THE following account of a phenomenon which I observed at Brighton on Sunday, November 3, 1907, may be of interest to the readers of "KNOWLEDGE." The weather was dull in the morning and some rain fell between 1 and 2.30 p.m. The clouds cleared somewhat in the south-west about 3 p.m., and the sun then came out. There was subsequently a brilliant sunset, the clouds being tinged with beautiful colours. Soon after 5 p.m. I saw the electric lights of Worthing. As it grew darker the lights became brighter. I then noticed that they scintillated or twinkled very much like stars. There was also the appearance of rippling or waves along the row of electric lights. I do not remember to have noticed any similar appearance of the twinkling and rippling of the lights anywhere else.

Worthing is twelve miles west of Brighton, and, owing to a slight bend in the coast-line, it is seen over the sea. The wind was from the south, and was only light in force. It is probable that there were inequalities in the velocity of the wind over the twelve miles of sea, and so these may account for the scintillation of the lights and also for the rippling, which was apparently from south to north.

I should be glad to know of anyone who has observed a similar phenomenon elsewhere.

Snow Rollers.

At the meeting of the Royal Meteorological Society last month, Mr. C. Browett read a paper describing the formation of "Snow Rollers," which he observed at Ryton-on-Dunsmore, near Coventry, on January 29-30, 1907. There had been some snow showers during the afternoon and evening, amounting to a depth of about 1½ inch. The next morning he noticed that the snow on the lawn to the east of the house was heaped up as though someone had run with a spade in front of him. The snow was cleared away to the bare grass (except for slight bars of snow across) in tadpole-like markings, whose tails all pointed to the direction from whence the wind had been blowing all night, viz., N.N.W., and at whose heads was heaped up the snow that had been on the bared grass, all neatly turned over in a roll. A few markings only were seen on the other lawns, and none at all in a field to the north, but on the drive and grass in front of the north side of the house there were markings in the opposite direction, but with little snow actually curled up. These were evidently caused by the deflection of the wind from the sides of the house. The temperature during the night ranged between 32° and 34°. A number of extracts giving descriptions of similar phenomena observed elsewhere were appended to the paper.

The following is an interesting extract from Buchan's "Handy Book of Meteorology":—

> "On the 5th March, 1862, about 9 p.m., the Rev. Dr. Charles Clouston, Sandwick, Orkney, observed the snow which was then covering the ground to be rolled up by the wind into masses increasing in size as they moved before it, which were blown backwards and forwards in the eddy-wind of the house. The same phenomenon had occurred in February, 1847, and was then described by him in the following terms: 'On examination, the masses were all found to be cylindrical, like hollow fluted rollers, or ladies' swan-down muffs, of which the smaller ones reminded me, from their lightness and purity, but most of them were of much greater dimensions and weight than any lady would choose to carry, the largest measured being 3½ ft. long and 7 ft. in circumference. The weight, however, was not so great as might have been expected from the bulk; so loose was the texture, that one 3 ft. long and 6½ ft. in circumference was found, on being weighed, to be only 64 lbs.; the centre was not quite hollow, but in all there was a deep conical cavity at each end, and in many there was a small opening through which one could see, and by placing the head in this cavity in the bright sun, the concentric structure of the cylinder was quite apparent. They might occupy 400 acres, and I counted 133 cylinders in one acre.'"

It seems that the flakes of a light fluffy layer of surface snow are made adhesive by a sudden rise in air temperature, while the under snow still remains cold and dry, and the particles of damp surface snow are enabled to adhere to each other, but not to the dry under snow. A strong wind may then push over little prominences or projections of the surface snow, and start them rolling, when, of course, they will continue to travel and grow until the resistances overcome the propelling power of the wind.

Study of the Weather as a Branch of Nature Knowledge.

A lecture on this subject was recently delivered by Dr. M. I. Newbigin to classes of teachers at Aberdeen and Edinburgh. This is an admirable Nature Study Lesson, and is printed in full in the *Scottish Geographical Magazine*. After giving an interesting and simple lesson on the study of the weather, Dr. Newbigin concludes as follows:—

"My aim in this lecture has been both to show what there is to teach in connection with weather, and to suggest methods of teaching it. As is the case in practically all the sciences, the great difficulty is to combine in a rational way the method of direct observation and of instruction, so as to give the taught something in the way of a practical appreciation of the subject. If I may recapitulate my suggestions, I would say, begin first by the most general and simple observations of wind and sky, sunshine and rain. Then introduce the barometer, and get a series of observations sufficient to answer a series of questions, such as: Does the barometer move or not? Much or little? Does the wind affect it? The temperature? Rain? At first, at any rate, I should be disposed to let the class take observations for a school week at irregular intervals rather than continuously, and then let them compare different weeks until they gradually acquired some notion of the meaning of average height. After the interest had been aroused it would be a good plan to give a series of more detailed lessons, and gradually introduce the consideration of cyclones and anticyclones, the reading of weather charts, and so forth. One would naturally take advantage of outstanding meteorological events as texts—a great storm such as that which wrecked the *Berlin*, a long frost, our late fine Easter; any one of these would form an interesting starting point. I should strive to make clear something of the romance of a meteorological map, to picture the many patient observers, widely separated from one another, who, day by day, records his quota of facts—facts whose full significance the individual cannot at the time fully see, but which he registers in the certain knowledge that they will fit into a clear and coherent whole. Man, now no more than ever he could, can alter the course of the winds, but within limits he has now so far conquered Nature that he can tell whither they come and where they will go, he has conquered time and space so far that he can send warnings of coming changes. Here, surely, are facts which are worth knowing, suggestions which are worth making. Again, though the meteorological map is an extraordinary triumph of skill, it has still many gaps. In our own British weather maps, so apparently a trifling matter as the opening of the cable to the Faröes and Iceland has greatly increased the value of the forecasts."

Mount Weather Observatory.

The U.S. Weather Bureau during the last few years has founded and equipped the Mount Weather Observatory, which is specifically devoted to research work. It is 1,725

feet above sea-level, and is located in Virginia, on the top of the Blue Ridge Mountains, some 20 miles south of Harpers Ferry, and 47 miles in a direct line from Washington. It is only six miles from Bluemont, the nearest railroad station, and is easily reached from that point along an excellent mountain road. It overlooks to the west the entire Shenandoah Valley from Strasburg to Harpers Ferry, while to the east all that portion of Piedmont Virginia between the Blue Ridge and the Bull Run Mountains is in full view. This extensive sweep of valleys, mountains, and plains affords rare opportunities for the study of storm formation and action. This location is satisfactory for the physical laboratory, and for the magnetic observatories. For solar work it is as well adapted as any place east of the Rocky Mountains; while for the study of the upper air it is peculiarly well situated, since kite flights can be obtained there almost daily through the entire year.

The "Bulletin of the Mount Weather Observatory," which will be published quarterly, will contain more or less detailed accounts of the researches conducted at that place. The first number has just been issued, and contains two papers, viz., (1) "The Methods and Apparatus used in obtaining Upper Air Observations at Mount Weather," by Dr. W. R. Blair; and (2) "The Use of Upper Air Data in Weather Forecasting," by Professor A. J. Henry.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Preservation of British Birds.

THE good work which the Royal Society for the Protection of Birds has done during the past few years must be familiar to all who have the best interests of ornithology at heart. And not the least valuable of their work is that which has been undertaken with a view to securing a more efficient protection for our native birds against the unspeakable greed of the mere egg-collector and the collector of rare local birds. Unscrupulous and insatiable, these men, masquerading as ornithologists, have wrought incalculable mischief on our native avi-fauna, and efforts are now to be made with redoubled energy to check their nefarious work at least during the breeding season.

To this end an appeal has just been issued for funds to enable a small army of watchers to be engaged for the purpose of protecting some, at least, of the more important breeding places and species which stand in special need of guardianship against these ornithological hooligans. The appeal has our hearty sympathy and cordial support, and we trust that many of our readers may feel prompted to contribute to the cause. Subscriptions may be sent to the Hon. Secretary of the Royal Society for the Protection of Birds, 3, Hanover Square, London, W.

Sabine's Snipe in Ireland.

The *Field* (February 1) contains a short account of a Sabine's Snipe, killed near Middleton, Co. Cork, on January 24. Though at one time Sabine's Snipe was recognised as a distinct species, it is now generally conceded that it is really but a melanic variety of the common snipe. It appears, however, to be something more than this. That is to say, the intensification of pigment is associated with a more or less marked change in the pattern of the plumage, wherein the most conspicuous feature is the absence of the longitudinal dorsal stripes of the back, and the stripes along the crown of the head.

Richard's Pipit in Co. Dublin.

British Birds for February records the fact that a Richard's Pipit was caught in a net on November 21, 1907, at Lucan, Co. Dublin. This species is apparently new to the Irish list.

Little Bunting in Kent.

Mr. W. Eagle Clarke, in *British Birds* for February, gives a short account of a Little Bunting (*Emberiza pusilla*) which had been captured, along with some linnets, at Dover on November 16, 1907, and remarks that quite a number of this species arrived at Fair Isle in the late autumn of last year.

Rare Birds in Scotland.

The Annals of Scottish Natural History for January, 1908, contains a remarkable list of rarities obtained in Scotland during 1907. From Fair Isle the following are recorded:—The short-toed lark (*Calandrella brachydactyla*); a small flock of little buntings (*Emberiza pusilla*); several yellow-browed warblers (*Phylloscopus superciliosus*), blue-throats, woodlarks, and a black red-start. The geographical position of Fair Isle, midway between the Orkneys and Shetlands, makes these records the more interesting.

But besides this, records are given of the occurrence of the red-breasted flycatcher (*Muscicapa parva*), on the Bell Rock (October, 1907); the rose-coloured starling (*Pastor roseus*), in Argyllshire, picked up dead during the early autumn of 1907; the glossy ibis (*Ibis falcinellus*), shot on the Lein Burn, Speymouth; an immature spoonbill, shot on the island of Canna, and another specimen secured in West Mull, November, 1907.

While Fair Isle promises to yield results hardly less important than those obtained in Heligoland, the Isle of May (Firth of Forth) seems likely to prove a serious rival to both these stations. This much may be inferred from the facts brought to light by Miss L. J. Rintoul and Miss E. V. Baxter, who spent a month on the island (September 9-October 8) during 1907.

They obtained the barred warbler (*Sylvia nisoria*), yellow-browed warbler (*Phylloscopus superciliosus*), and scarlet grosbeak (*Pyrrhula erythrina*). But besides these they give most interesting details concerning a number of uncommon species, some of the more important of which are recorded in *British Birds* for February.

PHYSICS.

By PROFESSOR ALFRED W. PORTER, B.Sc.

The Direction of Explosive Sounds.

MR. A. MALLOCK records in the Proceedings of the Royal Society that soon after the introduction of modern rifles, which give their projectiles a velocity much higher than that of sound, he noticed that when standing in a position in front of the gun and not far from the line of fire, the sound seemed to come, not from the firing point, but from some point considerably in front of the gun. He has recently been able to make a series of experiments upon this question, and the result of these is to verify what he expected, that the sound is not that of the explosion itself, but is due to the explosive wave, which is generated at each instant by the moving projectile. The direction in which an observer will hear this is along a normal to the wave. He therefore hears the particular sound generated at the point where this normal cuts the path of the projectile. Remembering that the wave travels with the velocity of sound, and that the trace of the wave travels along the trajectory with the velocity of the projectile, the latter can be calculated from the observed directions. The verification of the explanation given consists in calculating this velocity and comparing it with the values obtained by other means; the values are in very satisfactory accordance. "A sound which is caused by detached waves, such as those which accompany a bullet, can scarcely be said to have a pitch, but the wave-length is certainly small compared with the distance between the ears, and is indeed comparable with the dimensions of the bullet itself. It would seem, therefore, that the ears can determine the direction of a sound, not only by difference of phase, but by the actual difference in the times at which a single pulse reaches them."

Thermal Conductivities at Low Temperatures.

The result of an extended series of experiments made by Dr. C. H. Lees, is to show that the thermal conductivities of most pure metals decrease as the temperature

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rises within the range of temperature *minus* 160° to *plus* 100° C., while in the case of all alloys the reverse takes place. The value for nickel is found to increase with temperature (we would suggest that this is probably due to impurity, especially as Jäger and Diesselhorst had previously found it to decrease). The value for steel is practically constant.

Great interest attaches to these determinations because of the close theoretical connection that exists between electrical and thermal conductivity. It is only by accumulation of accurate experimental results that modern electronic theory will be supported or be shown to be imperfect.

A Damped Galvanometer.

The old Nobili astatic galvanometer is now usually replaced by one with a mirror, lamp, and scale; but for elementary teaching the old-fashioned one is still very convenient. One of the chief objections to it is that the pointer which is usually employed, has a great moment of inertia; when the sensitiveness is moderate the time of swing is consequently very great; and, moreover, the needle (and pointer) is a long time coming to rest. It is not generally known that this inconvenience can be completely removed, by making the needle system as light as possible and making the pointer from a very thin glass fibre, which can be dipped into black varnish at the ends to make its position on the scale easily observable. The instrument can in fact be made completely dead-beat in this way. The reason, of course, is that the moment of inertia of the pointer decreases as the square of its diameter, whereas the total friction only decreases slowly (approximately according to a logarithmic law, when the fibre is sufficiently fine). The rate of damping depends upon the ratio of the friction to the moment of inertia, and this ratio increases as the diameter decreases. When the correct diameter of fibre has been selected, the needle, when displaced by a current swings quickly into its fresh equilibrium position without oscillating at all about it.

ZOOLOGY.

By R. LYDEKKER.

Pearls from the Placuna.

ALTHOUGH the fact that Ceylon possesses some of the richest beds of the true pearl-oyster in the world, it is probably little known that it owns another source of pearls. This second supply is derived from the thin-shelled species of oyster commonly known as the window-pane oyster, and scientifically termed *Placuna placenta*. These oysters are found in certain backwaters, or lagoons, in the island, where, according to a recent report, they are carefully and extensively cultivated for the sake of their pearls, although no details are given as to the quality or quantity of the pearls thus obtained. As the interior of the placuna shell does not display the brilliant iridescence of the true pearl-oyster, the pearls obtained from the former probably lack the lustre of those from the latter.

American Caviare.

As the constant demand for Russian caviare all over the civilised world has resulted in a marked diminution in the number of sturgeon, Americans have endeavoured to find a substitute in the roe of the spoon-beaked sturgeon (*Polyodon spathulata*) of the Mississippi system. These fish, which grow to a large size, abound in some of the lakes bordering the lower part of the Mississippi Valley, into which they can effect an entrance only during floods, which occur, as a rule, but rarely. As they do not normally spawn in the lakes, no increase in the number of fish can take place between successive floods, and the lakes may consequently be exhausted of their supply by excessive fishing. Only about 4 per cent. of the fish captured yield roe, or caviare, and as this is of inferior quality to the Russian article, it is mixed with a certain quantity of the latter to improve its flavour before being put on the market. The flesh is dried or smoked, and sold in the States as sturgeon.

Eels and the Search-Light.

Danish investigators have found a means of checking the downward migration of breeding eels to the sea, whereby it is hoped that a valuable food-supply may be saved for the country, for these migrating eels when they have once reached the sea never return to their native rivers. The method is simplicity itself. A large acetylene search-light is placed by the river bank in such a position that its rays can be made to illuminate the comparative shallow water, and it is found that by this means the downward movement of the fish can be effectually checked.

A Pest Crusade in India.

By order of the Government of India steps are being taken to acquire a thorough knowledge of the various species of native animals harmful to man, domesticated animals, and cultivated plants, with a view to mitigate, so far as possible, the evils they inflict, and to see if effectual steps can be taken to diminish the numbers of the different pests. Rats are, of course, given a prominent place in the investigation, and an illustrated memoir has been published at Calcutta, which will enable ordinary persons to distinguish between the different species, and thus to recognise those taking the chief part in the spread of plague. Locusts and grasshoppers form the subject of a second memoir; while a third is devoted to mosquitoes and biting flies of all kinds. Fleas, ticks, bugs, and other unpleasant creatures will receive attention in later issues.

Papers Read.

At the meeting of the Zoological Society held on February 4, Mr. O. Thomas discussed a collection of mammals from the islands of Tsushima, between Corea and Japan; while Mr. C. T. Regan described certain new fishes from Corea. In a third paper Mr. T. Goodey described certain structures connected with the reproduction of the medusas of the genus *Aurelia*. At the meeting on February 18, Mr. R. Staples-Browne discussed the inheritance of colour in domesticated pigeons, with special reference to reversion; Mr. Thomas contributed a list of mammals from the Mongolian Plateau; while Mr. G. T. Bethune-Baker gave descriptions of new species of butterflies from Africa and New Guinea.

REVIEWS OF BOOKS.

ASTRONOMY.

A General Catalogue of Double Stars Within 121° of the North Pole, by S. W. Burnham. Published by the Carnegie Institution of Washington. In two large quarto. volumes. (1) The Catalogue (pp. lv. and 256 and 18), and (2) Notes (pp. viii. and 1,086).—In common with other workers who have been engaged in breaking new ground, the author of this work felt the want of a complete index to the labours of previous pioneers, and finding such an index not to be in existence, set to work to make one for himself. His commanding reputation as a double-star observer, founded on numerous discoveries in a field supposed by some judges to have been worked out, has, on the mere hint of the preparation of this great catalogue, postponed the publication of similar works in other quarters, so that for every reason it should, to use a hackneyed phrase, supply a long-felt want with exceptional completeness. Its purpose being to include all discoveries of double stars, with sufficiently full information in regard to subsequent measures, the only obvious limitation on its first part is the publication of such discoveries. Anything unpublished is, of course, outside the author's ken, and cannot complain of omission. It appears to us that in his anxiety to do full justice to discoveries, he has included too many, for there are numerous examples of "discoveries" that could never have been regarded as such by their "discoverers." If fault is to be found, however, with Part I., we are inclined to suggest that the limitation to stars within 121° of the North Pole (why 121°?) is a considerable drawback, and that, with the *carte blanche* of the Carnegie trustees, it would have been well worth while to have brought the places to a

more modern date than 1880. Precession tables are given, but a great economy of the user's time for years to come would have been effected by a piece of clerical work done once for all before publication. Of Part II., the notes to the Catalogue, we can but admit that they are voluminous. The author gives what he considers sufficient observations to determine the character of the relative motion, if any, of the various pairs or small clusters of stars. It is impossible within our limits to deal fully with the way in which this conception has been carried out. We might argue that all separate observations should have been given in full; but the author considered that his judgment as to the omission of many measures and the lumping together of others would be of great value to those in search of orbits, so he has contented himself with giving full references. We should imagine that much of the criticism which a great work like this is bound to meet will fasten on this quasi-personal feature of the work. It will be asserted that in a general catalogue bias should have no place, and we are bound to admit that in some instances there are appearances that can hardly be attributed to anything else. Again, it will be said that the finest observer in the world is not necessarily the best, or even a good, judge of other people's work, or even of the interpretation of his own. These suggestions we do not make without plausible grounds, a few of which we will give. Looking through the book we frequently find observations attributed to "Gr. Obsy.," but the index of abbreviations does not inform us that this stands for Greenwich Observatory. This may possibly be an inadvertence, as it is not the only omission of the kind. Internal evidence shows that "Gr. Obsy." includes more than one observer, and often more than one year of observation. This treatment does not seem to have been applied, at any rate not to the same extent, in dealing with American observatories, and it is quite impossible to suggest inadvertence to explain this. A concrete case, for which no plausible excuse presents itself, will be found on page 1,003. Under δ 1,146 we find a list purporting to include all the observations, and among them is printed one in brackets, apparently to intimate that Burnham considered it of no value. It is, however, an observation by Lewis, of Greenwich Observatory, one of the leading English observers and authorities on double-star astronomy, as witness his great memoir on the Struve Double Stars, published last year by the Royal Astronomical Society. If, then, an observation by such a man were so hopelessly discordant as the one given in brackets, it is only reasonable to assume that it did not belong to the star to which it was entered, and should at the very least be omitted. Without further investigation or knowledge of the facts one would say, "A slip must have been made by Lewis in entering the observation to the wrong star, and in common courtesy it ought to have been traced to its proper place or omitted." It happens, however, that on page 1,002, the self-same observation appears, under β 1,037, to which it obviously belongs, and to which, by the printed reference, Lewis himself assigned it. It is, therefore, exceedingly difficult to avoid an inference of bias, as the extreme carelessness which would have to be assumed on any other hypothesis is a poor compliment to the Carnegie Institution. Instances of apparently erroneous conclusions are not hard to find. Turning to the better-known stars we find 61 Cygni described as showing practically rectilinear motion, which is not in accordance with the diagram given, which shows an undeniable curve. Under δ Equulei, prabably the shortest period binary known, after referring to Hussey's exhaustive paper on the observations up to 1901, the author says it is unnecessary to give that material again, and for the period after the summer of 1901 he has given only selected measures, and these only from the Lick Observatory, and showing practically no change in angle in nearly four years. It would surely have been worth while to have at least attempted to explain the apparent lack of agreement. Taken in conjunction with a remark under κ Pegasi, which was, until Hussey's discussion of δ Equulei, regarded as the most rapid binary, and which is perhaps Burnham's most striking discovery, it seems almost as if Burnham disputed the validity of Hussey's period for δ Equulei, and so refrained from further discussion, in which case one would like to know on what principle the observations he gives for δ Equulei were selected. But now having indicated grounds on which bias or errors of judgment might be alleged, there is no doubt that the books will be a necessity for every double-star observer or investigator, that they hold an absolutely unique position in the literature of the subject, and that they declare with no uncertain sound the size of the field of double-star astronomy, and the great need for more observers and more systematic observations of "old" pairs of stars, compared with which the search for "new" ones is rapidly becoming of less and less relative importance.

PHYSICS.

A Text-Book of Practical Physics, by Dr. W. Watson (London: Longmans, 1907; 9s.).—This is the most complete text-book of practical physics suitable for senior students that we have seen. It is intended as a work of reference for those working in a physical laboratory. Practically all the operations which can be performed in a laboratory are described here with very great completeness, so that it is easily adaptable to the particular circumstances which may obtain in any individual case. There is very little to which we can give anything but praise. We would, however, point out for the sake of the student that formula 3 on page 191 retains some terms of the second order while neglecting others which may be equally important.

Thermodynamics of Technical Gas Reactions, by F. Haber, translated by Arthur B. Lamb (London: Longmans, 1908; 10s. 6d. net).—An excellent translation of a masterly series of lectures. No one who wishes to be abreast of the most recent work on the connection between the heat of a reaction and the proportions of the amounts of the reacting materials present in an equilibrium mixture can afford to be without it. For Dr. Haber has introduced so much critical discussion of the views of his contemporaries that it forms an extremely valuable treatise. It is written throughout from the standpoint of technical applications.

BOOKS RECEIVED.

Astronomy for the Young. By W. T. LYNN, B.A. (London: S. Bagster & Sons, 1907, fifth edition, pp. 64, 6d. net.)

The Old Riddle and the Newest Answer. By J. GERARD, S.J. (London: Longmans, Green & Co., 1907, fifth edition, pp. 121, 6d. net.)

MESSRS. ISENTHAL'S indispensable catalogue of electrical apparatus has just been published for the current year. The sections are bound together and embrace electro-magnetic instruments, moving coil instruments, hot-wire instruments, wattmeters, special types of switchboard instruments, and devices connected with insulation. The descriptions of the various types of apparatus are extremely clear and workmanlike, and the illustrations and the diagrams alike are very useful in enabling a proper apprehension of the instruments' uses and capabilities to be reached.

MR. ROBERT BROGDEN, of Colville Square, W., sends us the "Biological Material" catalogue, which has special reference to the natural history specimens which he supplies. Particular attention may be directed to the large number of mounted spirit specimens, including skeletons of a number of species, type and metamorphosis series, and index collections containing representative members both of vertebrates and invertebrates. We may also call attention to the interesting selection of models, both zoological and anatomical, by Osterloh and other makers.

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MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page* 46.)

Cutting Sections by the Celloidin Method.—The relative advantages and disadvantages of the celloidin method have already been discussed. No heat is required throughout the process, which is sometimes an important consideration with delicate objects, nor is it necessary to clear the objects beforehand. There is thus no danger of charring on the one hand, or of distortion or shrinking on the other. The transparent celloidin makes the orientating of objects, when requisite, an easy matter; indeed, with very transparent objects it may be necessary to stain them slightly to enable them to be seen and recognised. The process requires little attention, and does not need watching, unlike paraffin embedding; but against this must be put the fact that the procedure is generally a lengthy one, as will be seen later. Indeed, it can in most of its stages be prolonged indefinitely, which may at times be even a convenience; but three days is a fair average time required. The celloidin method is suitable for larger objects than can be cut in paraffin, and for very brittle objects, which require firm support, nor does the celloidin require removal afterwards; but very thin sections cannot be cut with celloidin, 10μ being about the minimum, though the difficulties in this respect are somewhat less since the introduction of what is known as the "dry method." It is, therefore, of little use for cytological work. It is a good rule to use paraffin where possible.

Celloidin is really a patent preparation of collodion, which is a solution of gun-cotton in ether and strong alcohol. Collodion may be used if necessary, as it is cheaper, but it is better to use celloidin, and it may be bought ready for use in solution, or more generally in horny semi-transparent cubes, of which those supplied by Schering or Grübler are the most trustworthy. It must be cut into thin shreds, and as old celloidin gets very hard, it is well not to keep it too long. As it contains a certain amount of moisture the shavings must be well dried in the open air. They are then dissolved in equal parts of alcohol and ether, which must be what is known as "sulphuric-ether" and free from acid. Elsching recommends that the celloidin be dissolved independently in alcohol and well stirred, and then an equal quantity of ether added to the solution 24 hours later and again stirred, at least another 24 hours being allowed to elapse before the solution is used. It must be shaken frequently to keep the heavier part from settling to the bottom. Two solutions will be required, one, known as the "thin solution," containing about five parts of celloidin by weight to 50 parts of absolute alcohol and 50 parts of ether by measure (5 per cent. solution), and the other, known as the "thick solution," containing about 10 parts of celloidin by weight to 50 parts of absolute alcohol and 50 parts of ether by measure (10 per cent. solution).

Objects to be embedded should preferably be about 2 to 8 mm. thick; the smaller the better. They must be fixed, washed, and *thoroughly* dehydrated in accordance with the principles already laid down in the earlier articles of this series ("KNOWLEDGE," 1907, pp. 166 and 190), by means of graduated alcohols, finishing with 24 hours in 95 per cent. alcohol; and then transferred to absolute alcohol for another 12 to 24 hours, with preferably at least one change of alcohol. They must then be transferred to a mixture of absolute alcohol and ether in equal parts for yet another 12 to 24 hours, and then put first into the thin celloidin and then into the thick celloidin, so as to get a gradual infiltration throughout. The time required in these celloidin solutions varies within very wide limits; it is never less than 24 hours, and often requires some days, and for really large sections weeks or even months may be necessary. But, generally speaking, for objects of the size mentioned, 24 to 36 hours is sufficient, the thin celloidin requiring rather a longer time than the thick celloidin. The object will then be ready to affix to the support upon which it is to be cut in the microtome.

This support may be made of wood, glass, or vulcanite, but cork is to be avoided, as it lacks sufficient rigidity. Small wooden blocks a little larger than the object are, perhaps, as easy to obtain as any, though vulcanite is very useful. The wooden blocks should be rectangular and cut across the grain. The end must be dipped into the ether-alcohol solution for a minute or so, and then into the thick celloidin solution, then dried. This is partly to give a hold to the object, and partly to prevent air-bubbles finding their way from the wood into the celloidin mass when the object is fixed in position.

The object may now be removed from the thick celloidin and pressed lightly on the dry surface of the block, or *vice versâ*. It may be necessary to add a little celloidin around it to ensure its firmer support. A better way is to run the thick celloidin into a mould made out of a tiny paper box; to utilise the well-known L-shaped metal embedding blocks; or to use a *dry* watch-glass. A simple and efficient method is to smear a strip of stiff note-paper with a thin film of vaseline and to wrap it, vaselined side inwards, around the end of the prepared block, tying it on with cotton-thread, and thus forming a neat little cup of suitable size *in situ*. A little thick celloidin is poured into the cup, the object is transferred into it with a needle or forceps, and held in the required position, whilst more thick celloidin is poured around it until the cup is full.

The next process is the hardening of the celloidin mass. When a film has formed on its surface, or when it shows just a slight indentation with the ball of the finger (not with the nail), the whole block is put into a small jar, or desiccator, containing chloroform. It can be put bodily into chloroform, though it need not be covered with it, but it is better to utilise the vapour only, by using a few drops of chloroform at the bottom of the receptacle and keeping the same carefully closed with a plate, the chloroform, of course, evaporating very rapidly and slow evaporation being advantageous. Eighty-five per cent. alcohol or benzene can be used instead of chloroform, but the process is slower. The alcohol bottle should not be tightly closed. The time required for the hardening will be from one to three hours, though a day or more may be necessary. After this the object is to be transferred to 70 to 85 per cent. alcohol, and here it may remain indefinitely without further attention, until required. Sometimes bubbles form in the celloidin, but an hour or two in ether vapour

will generally rectify this, and sometimes the celloidin becomes opaque when treated with chloroform, but it becomes transparent again after a time.

(*To be continued.*)

Royal Microscopical Society.

January 15.—Annual Meeting. Mr. E. J. Spitta, M.R.C.S., L.R.C.P., in the chair. Mr. Rousselet described a microscope, more than 100 years old, of the type of "Jones' most improved Compound Microscope," presented to the Society by Mr. A. S. Michie. Mr. Conrad Beck exhibited and described a new method of showing living bacteria by dark-ground illumination, by means of a modified and adjustable parabolic illuminator, with Nernst lamp and mono-chromatic blue light. Mr. J. W. Ogilvy exhibited some microscopes of new design made by E. Leitz, fitted with an improved form of fine adjustment, with safety arrangement to both fine and coarse motions. The Annual Report and Treasurer's Balance-Sheet were then read and adopted, and the officers and Council for the ensuing year ballotted for and elected, Lord Avebury being elected President. In the absence of the author, the Secretary read a paper by Mr. W. Wesché "On the Microscope as an aid to the study of Biology in Entomology, with particular reference to the food of Insects." The paper was illustrated by lantern slides showing insect ingesta *in situ* in the alimentary system and otherwise; by plates; and by many slides under microscopes. It was announced that at the meeting on March 18 Lord Avebury would deliver his Presidential Address, and that his subject would be "On Seeds, with special reference to British Plants."

Quekett Microscopical Club.

January 17.—The President, Mr. E. J. Spitta, F.R.A.S., F.R.M.S., in the chair. Two papers, announced to be read, were postponed, owing to the unavoidable absence through illness of the authors. Messrs. Watson exhibited under microscopes a large number of preparations of insects and insect parts, and Messrs. Baker exhibited with the lantern a number of interesting slides of pond-life and other low organisms. Mr. E. Large exhibited on the screen, by the use of the projection polariscope, a number of very beautiful preparations of thin slices of selenite crystals, some, showing twinning, being worthy of special note.

Museum Beetle.

Mr. A. J. Ewart has made an interesting contribution to the Journal of the Linnean Society on the physiology of the museum beetle, *Anthrenus museorum*, whose larvæ have been working terrible havoc in the National Herbarium at Melbourne. The only way in which its ravages have been checked has been by placing the portfolios of plants for two or three days at regular intervals in a chamber impregnated with carbon bisulphide vapour. Naphthalin has no effect upon the larvæ. The most remarkable feature about the larvæ is their power of feeding on dry materials without any apparent supply of water (68.5—71.8 per cent.) as do the larvæ of allied insects. Possibly the water is chemical in origin, being set free in the animal's body from the oxidation of carbon in respiration, derived from the carbohydrate food. Experiments tend to show that when the larvæ are actively feeding and respiring, the oxidation of the carbon in their carbohydrate food sets free a certain amount of water, which, aided by the imbibed water from the plant tissues, suffices, if the latter is over 10 per cent. in amount, for the aqueous requirements of the larvæ. Bacteria are abundant in the alimentary canal, and since these bacteria feed on the carbohydrate food, and oxidise its carbon under conditions where no transpiration of water as vapour is possible, a certain increase in the percentage of free water in the alimentary canal must be produced in this way. The grubs do not seem to have any power of condensing water vapour from the air.

Microscopical Material.

By the kindness of Mr. J. Strachan, of Ballyclare, I have for distribution to such of my readers as care to apply for it, some Ferruginous Sand from one of the glacial deposits in the Six-mile Valley, Co. Antrim, concerning which Mr. Strachan writes: "It makes rather an attractive slide when mounted in Canada balsam and examined with a ¼-inch objective. The most interesting feature in this sand is the colouring matter, viz., oxide of iron, which stains and coats many of the grains in varying intensity, from pale yellow, passing through reddish-brown, to a deep blood-red. The jet-black opaque particles consist of magnetic oxide of iron, and are attracted by the magnet. The majority of the sand grains are sharp-edged, not having been rounded by attrition." Applications must be accompanied by a stamped-addressed envelope, and by the coupon to be found in the advertisement columns of this issue.

Notes and Queries.

W. K. B. (*Tientsin*).—I know very little of the objectives you mention, as they are seldom met with, and I have no reason to suppose that the higher price is justified. I should recommend your getting objectives by makers more widely known as makers of microscopes, objectives, etc. I do not think I can advise you better than in the pages devoted to the choice of objectives in my "Elementary Microscopy," to which you refer.

A. G. R. (*Yorkshire*).—I should recommend paraffin for making large sections of an insect like the cockroach, the more so as you will probably be content with comparatively thick sections. The important point is the preparation of the insect beforehand, especially where, as in this case, there is a hard chitinous covering to be cut through, which will be apt to spoil your sections. As you say, to go into the various methods would take more space and time than I can give here, but I would recommend your getting Miall and Hammond's monograph on the Harlequin Fly, published by the Clarendon Press in 1900, which is a model of what such a study should be, and which contains in the appendix instructions as to preparing, sectioning, and staining. I would also recommend you to obtain Miall and Denny's "Structure and Life-History of the Cockroach," published in 1886, by Lovell, Reeve, and Co., which will be of the utmost service to you.

Microscopical Material.—From time to time I am able, by the kindness of individual friends and readers, to distribute various kinds of microscopical material, and I shall be glad if any who can help by sending me interesting material will do so. The large number of applications received shows how welcome such material is to workers all over the country, and not infrequently I get letters afterwards expressing appreciation of material that seems at first sight of no great interest, but which has well repaid study. Therefore I hope others will help in this distribution. I need scarcely say that the distribution gives me personally a considerable amount of trouble, and I consider myself justified in ignoring without explanation any applications which do not conform to the very simple conditions. Sometimes the addressed envelope is omitted, sometimes the coupon, and not infrequently an application arrives in which the only condition omitted is the stamp for postage! Will any disappointed applicants who may be wondering at getting no answer please note?

[*Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge, Correspondents are requested not to send specimens to be named.*]

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The Face of the Sky for March.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.48 and sets at 5.38; on the 31st he rises at 5.40 and sets at 6.29. The Sun enters the sign of Aries at 0.27 a.m. on the 21st, when Spring commences.

Sun-spots may usually be observed, though they are not very numerous.

The positions of the Sun's axis, centre of disc, and Heliographic Longitude, are given below:—

Date.	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Mar. 1 ..	21° 44′W	7° 14′	290° 17′
,, 11 ..	23° 56′W	7° 13′	158° 31′
,, 21 ..	25° 27′W	6° 58′	26° 42′
,, 31 ..	26° 17′W	6° 31′	254° 49′

The Zodiacal light should be looked for in the west, a few hours after sunset.

THE MOON:—

Date.	Phases.	H. M.
Mar. 2 ..	● New Moon	6 57 p.m.
,, 9 ..	☽ First Quarter	9 42 p.m.
,, 18 ..	○ Full Moon	2 29 a.m.
,, 25 ..	☾ Last Quarter	0 32 p.m.

OCCULTATIONS.—The star δ^3 Tauri (mag. 4·2) is the only bright star occulted before midnight; disappearance takes place at 10.10 p.m., and reappearance at 10.32 p.m. on the 8th.

THE PLANETS.—Mercury (Mar. 1, R.A. $22^h\ 33^m$; Dec. S. 5° 15′. Mar. 31, R.A. $23^h\ 0^m$; Dec. S. 8° 28′) is out of range during the former part of the month, since the planet was inferior conjunction on the 29th of the last month. Towards the end of the month the planet is a morning star in Aquarius, rising at 5.11 a.m. on the 27th, on which date he is at greatest Westerly elongation of 27° 49′.

Venus (Mar. 1, R.A. $1^h\ 12^m$; Dec. N. 7° 49′. Mar. 31, R.A. $3^h\ 25^m$; Dec. N. 20° 51′) is a brilliant object in the evening sky looking South-West immediately after sunset. The apparent diameter of the planet is increasing, being now 16″, whilst 0·7 of the disc is illuminated; thus the appearance in the telescope is gibbous, similar to the Moon ten days old.

Venus will be in conjunction with the Moon on the 5th, and with the star δ Arietis on the 27th; in the latter case the planet will only be about 2′ N. of the star. On the 1st, the planet sets at 9.20 p.m., and on the 31st, at 10.49 p.m.

Mars (Mar. 1, R.A. $2^h\ 10^m$; Dec. N. 13° 40′. Mar. 31, R.A. $3^h\ 32^m$; Dec. N. 19° 54′) may still be observed in the evening, but shining with diminished lustre as its distance from the earth increases. The planet sets at 10.50 p.m throughout the month.

Ceres (Mar. 31, R.A. $13^h\ 6^m$; Dec. N. 10° 29′) is in opposition to the Sun on the 31st, when its magnitude is 7·0; its position is about 1° South of ϵ Virginis.

Pallas (Mar. 10, R.A. $11^h\ 18^m$; Dec. N. 0° 42′) is in opposition to the Sun on the 10th, when its magnitude is 6·8; the minor planet is situated in Leo and at the time of opposition is about 1¼° South of the star 79 Leonis.

Jupiter (Mar. 1, R.A. $8^h\ 30^m$; Dec. N. 19° 51′. Mar. 31, R.A. $8^h\ 24^m$; Dec. N. 20° 9′) is a very brilliant object throughout the night. The planet is well placed for observation, being already above the horizon at sunset and on the meridian about 9 p.m. near the middle of the month, when he sets about 5 a.m. On the morning of the 2nd, the planet will appear with only Satellite II. in attendance; Satellites I., III. and IV. being invisible from 3.41 to 4.26 a.m.

The following table gives the satellite phenomena observable between 8 p.m. and midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.
Mar.				Mar.				Mar.			
1	IV.	Oc. R.	9 22	11	I.	Sh. I.	10 9	19	I.	Ec. R.	11 32
	IV.	Ec. D.	11 43		I.	Tr. E.	11 34	20	I.	Sh. E.	8 53
2	II.	Ec. R.	9 33	12	I.	Ec. R.	9 37	25	II.	Sh. I.	8 44
3	I.	Oc. D.	10 8		III.	Tr. E.	9 54		II.	Tr. E.	9 25
4	I.	Sh. I.	8 15		III.	Sh. I.	10 0		II.	Sh. E.	11 41
	I.	Tr. E.	9 47	16	II.	Oc. D.	9 50	26	IV.	Tr. E.	8 23
	I.	Sh. E.	10 35	18	II.	Sh. E.	9 3		I.	Oc. D.	10 1
5	III.	Sh. E.	9 43		IV.	Ec. R.	10 30	27	I.	Sh. I.	8 27
9	IV.	Tr. I.	11 42		I.	Tr. I.	11 2		I.	Tr. E.	9 39
10	I.	Oc. D.	11 55	19	I.	Oc. D.	8 11		I.	Sh. E.	10 48
11	I.	Tr. I.	9 14		III.	Tr. I.	9 47	30	III.	Ec. R.	11 27

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (Mar. 1, R.A. $23^h\ 55^m$; Dec. S. 2° 48′. Mar. 31, R.A. $0^h\ 9^m$; Dec. S. 1° 20′) is in conjunction with the Sun on the 21st, and hence is unobservable.

Uranus (Mar. 15, R.A. $19^h\ 11^m$; Dec. S. 22° 50′) is a morning star in Sagittarius, rising about 3 a.m.

Neptune (Mar. 15, R.A. $6^h\ 52^m$; Dec. N. 22° 5′) is situated in Gemini about 36′ North of the star ζ Geminorum. The planet is difficult to identify among the numerous small stars appearing in the same field of view, and as he is practically stationary this month, he cannot readily be detected by his relative motion, moreover, it requires a high power (about 300) and good definition to distinguish his disc.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics.
	h. m.			
Mar. 1-4 ..	11 4	+ 4°	τ Leonis	Slow; bright.
,, 14 ..	16 40	+54°	μ Draconis	Swift.
,, 24 ..	10 44	+58°	β Ursæ Maj.	Swift.

Minima of Algol occur on the 5th at 9.2 p.m., 8th at 5.51 p.m., 25th at 10.45 p.m., and 28th at 7.33 p.m.; its period is $2^d\ 20^h\ 49^m$, by which other minima may be deduced.

DOUBLE STARS.—γ Leonis, X.^{h} 14^m, N. 20° 22′, mags. 2, 4; separation, 3″·6. In steady air, the prime requisite for double star observations, this double may be well seen in a 3-in. telescope with an eyepiece magnifying about 30 to the inch of aperture, but on most nights one with a power of 40 is better.

The brighter component is of a bright orange tint, whilst the fainter is more yellow.

ι Leonis, XI.^{h} 19^m, N. 11° 5′, mags. 4, 7½; separation 2″·2. A pretty double of different coloured stars, the brighter being yellow, the other blue. This object requires a favourable night and a fairly high power on small telescopes.

α Leonis (*Regulus*) has a small attendant about 180″ distant, magnitude 8·5, and easily seen in a 3-inch telescope.

α Canum Venat (*Cor Coroli*), XII.^{h} 52^m, N. 38° 49′, mags. 2·5, 6·5, separation 20″; easy double, can be seen with moderately low powers, even in 2-in. telescopes.

XUM